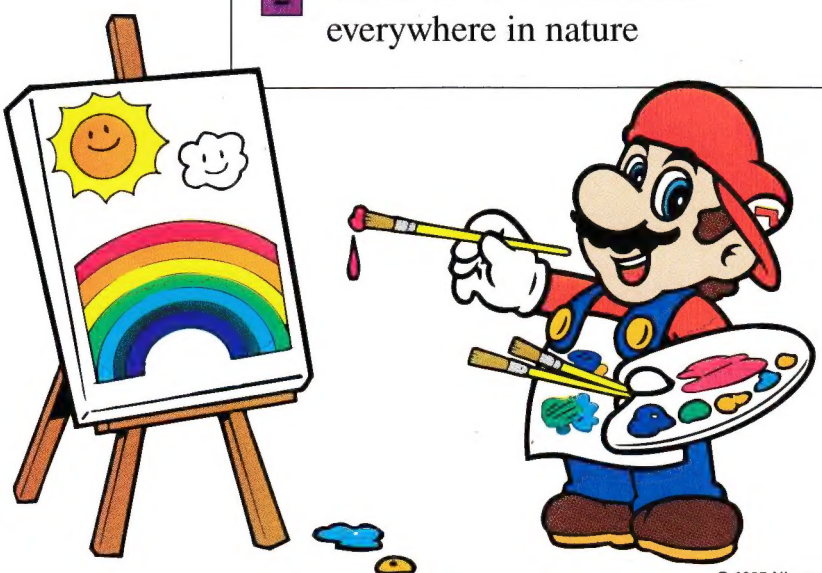
Where do colors come from?

SCIENCE AND TECHNOLOGY

1. From a light source such as the sun or a lamp
2. Colorants which are found everywhere in nature



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Colors

Light sends out rays that illuminate things and make them visible. Without light you wouldn't see color!

1 **Colors come from a light source such as the sun or a lamp.**

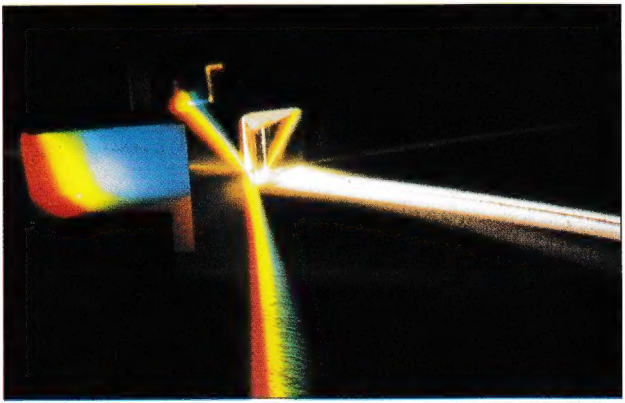

Photo Robinson-Science Source / Explorer

The breaking up of white light, as proved by Sir Isaac Newton, produces a rainbow of colors.

Rainbow of Colors

Sunlight looks white. So does the bulb in the lamp you're using. But so-called "white light" is really made up of lots of colors. To prove it: shine a flashlight through a prism or crystal. What comes out the other side? A "rainbow" of colors!

Absorbs and Reflect

Everything we see as having color contains pigments that absorb some of the colors in light and reflect others back to our eyes. When you look at a red poppy, it looks red because the flower absorbs every color but red, and only the red light is reflected back to your eyes. Does this explain why you don't see color in the dark? (You need light to get a reflection!)

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How do elevators work?

SCIENCE AND TECHNOLOGY

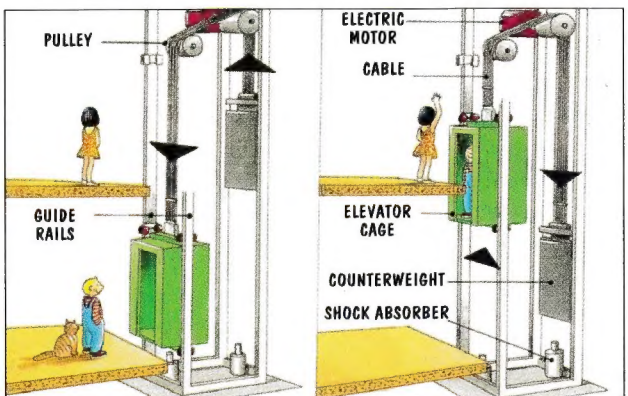
1. An electric cable hauls the elevator up on a ratchet
2. An electric motor winds a counterweighted cable around a pulley

© 1995 Nintendo

Elevators

Elevators work on the same principle as a bucket in a well. A strong cable is wound around a pulley, then the elevator is hauled up or down.

2 An electric motor winds a counterweighted cable around a pulley to make an elevator work.



Ill. J. Dang

The counterweight balances the weight of the elevator plus the weight of the passengers in it.

Counterweights

As part of an elevator, a huge counterweight, made of various metal parts, slides up and down between two guide rails. When the elevator is at the top, the counterweight is at the bottom. When the counterweight is at the top, the elevator is at the bottom. And if the elevator stops at a floor halfway in between, the counterweight also stops halfway.

A Balancing Act

As an elevator goes up, it acts as a brake on the counterweight, and vice-versa. There are as many stop buttons as there are floors in the building. If you press 3, the electricity is switched off in the elevator's wires above the third floor and the elevator stops at 3.

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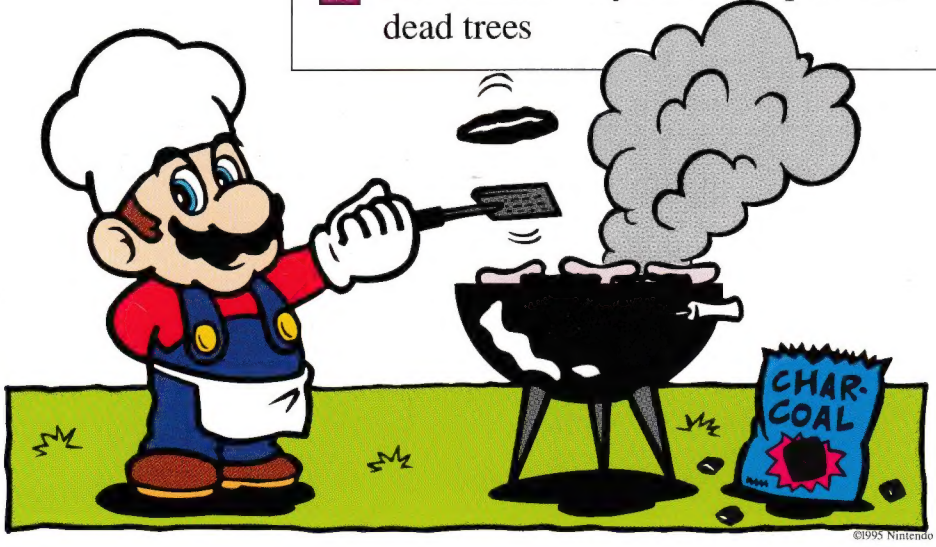
What is coal?

SCIENCE AND TECHNOLOGY

1. Compressed debris
2. Fossilized shellfish and mollusks on the sea bed
3. Accumulated layers of compressed, dead trees



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Coal

Coal is the result of millions of years of pressure on the remains of plants that died.

3 Coal is accumulated layers of compressed dead trees.

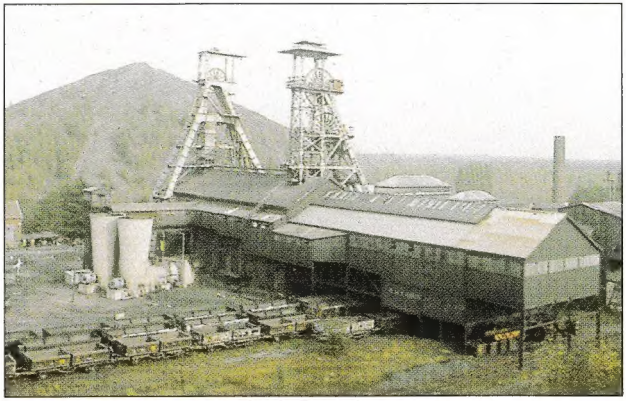

Photo Dupont / Explorer

Coal is removed from the ground in mines or open pits. It played a big part in the growth of manufacturing in the 19th century. But then electricity and oil replaced coal as the fuel of choice.

Millions of years ago, much of the land was covered by huge lakes. Leaves, trees, stalks, and roots rotted on the floors of the lakes. Millions of years later, the pressure from above has squeezed the dead plants to form hard, black coal.

Coal is a valuable fuel; it burns well, giving off a lot of heat. The older the coal, the better it burns. The oldest kind, anthracite, is very hard and shiny. The youngest, lignite, is softer, and it takes three times as much lignite to generate the same amount of heat as with anthracite!

Because it's made from plant remains, or fossils, coal is called a fossil fuel. The coal we use today formed between 400 million and 1 million years ago. If we ever run out of coal, it will take millions of years to create more!

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Where does leather come from?

SCIENCE AND TECHNOLOGY

1. Leather is a by–product of oil
2. The skin of animals
3. Leather comes from latex

©1995 Nintendo

Leather

The most common animal skins used for leather are pigskin, calfskin, sheepskin, and goatskin.

2 Almost any animal skin can be made into leather.

Photo ERL / Sipa-Icono

"A tannery" Marmottan Museum

The skins of lizards, crocodiles, and even sharks are used to make fancy leather products. Leather is strong and durable, and it can be made as soft as cloth or as stiff as wood.

Turning skin into leather is called tanning. Once most of the meat, fat, and hair have been taken off, the skin is soaked in salty water to prevent it from rotting. The water also helps to soften the skin. Next, it's treated with lime to remove any hair, washed again, and soaked in a barrel of tannin, a product made from plants such as oak and ash trees.

The skin may also be soaked in chlorine or other chemicals, then it's oiled to make it waterproof. It may also be dyed. Finally, it's made into shoes, purses, clothing, sofas, saddles, boots, gloves, and even watch straps!

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What is paper made from?

SCIENCE AND TECHNOLOGY

1. A fibrous material taken from trees
2. A paste-like mixture of water, gunpowder, and chalk
3. A paste-like mixture of clay and candle wax

©1995 Nintendo

Paper

Paper is made from matted tree fiber. The fiber, or cellulose, is what's left after wood is boiled in a solution to dissolve the rest of the wood. The fiber is dried and shaped into sheets of paper.

1 Paper is made with a fibrous material taken from trees.

Photo © Beaulieu / Explorer

It takes many trees to produce giant rolls of paper like these—the kind used for printing newspapers.

Once trees are cut down, the logs are sent to a mill where they are turned into wood pulp. Pulping may be done using a grater or chemicals.

Cooking With Chemicals

Wood chips and chemicals are cooked under pressure until nothing is left but the cellulose. This paste is refined, kneaded, and mixed with color or chemicals to make waterproof, absorbent, or frosted paper.

From Paste to Paper

The wet paste mixture is spread out on metal webs and dried between large heated cylinders. Soon paper is ready on large spools or cut in convenient sizes.

Recycle It!

Recycling paper helps to save trees. Manufacturers can refine old paper and make it just like new. And recycling saves energy because making paper from scratch requires a lot of water and electrical energy. So save a tree... recycle!

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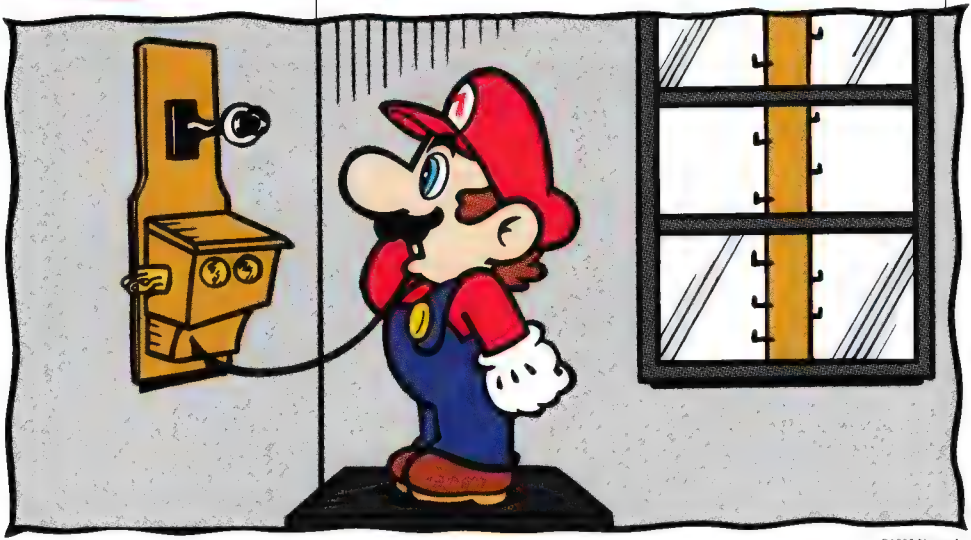
Who invented the telephone?

SCIENCE AND TECHNOLOGY

1. American Isaac Singer
2. Frenchman Louis Braille
3. American Alexander Graham Bell



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Telephone

In 1876, American Alexander Graham Bell invented the first electric telephone. Electricity was used to transmit and reproduce resonant vibrations of the voice.

3 The telephone was invented by American Alexander Graham Bell.

Photo: Culver Pictures, Inc

The first message transmitted by Bell was, "Mr. Watson, come here. I want you!"

Today we can talk to astronauts orbiting Earth, so it's pretty hard to believe there was a time when there were no telephones. (What did teenagers do in those days?)

Bell's Brainstorm

Wire coils, electromagnets, membranes, acid, and a few vibrations are some of the things that Alexander Graham Bell and his assistant, Tom Watson, used to make the first telephone. But all together the stuff worked! Bell discovered that any vibrations captured by one membrane in his telephone set-up disrupted the electric current passing by the electromagnet. This disruption was then transmitted to the other electromagnet and membrane as identical vibrations—the same sound had been sent across wires! How Bell put his invention together may sound complicated, but if you've ever looked at the insides of a phone, you know they use the same basic principles today.

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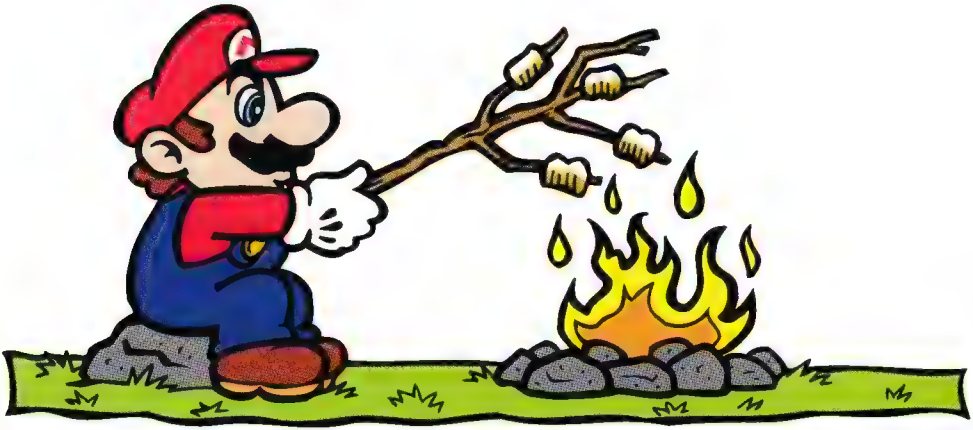
When did humans discover fire?

SCIENCE AND TECHNOLOGY

1. About 3,000 years ago
2. About 50,000 years ago
3. About 250,000 years ago



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Fire

The most ancient proof discovered that ancient humans used fire has been carbon dated to about 250,000 years ago. Our ancestor, Homo erectus, scientists say, knew how to make and use fire.

3 Humans discovered fire about 250,000 years ago.

Photo © Ferrero / Explorer

Aborigines in Australia use some pieces of wood to light a fire.

Scientists say it's possible that our ancestor, Homo habilis, who lived approximately 1.5 million years ago, knew that fire was the result of lightning. But they say that Homo erectus, who lived between 1.6 million to 200,000 years ago, seems to have been the first human to have produced fire and used it systematically.

A Wooden "Lighter"

Early humans created a spark by placing the tip of a stick in some dry wood, then twisting the stick back and forth between their hands. (The same way many young people learn to start a fire in summer camp!) The resulting spark was coaxed into a fire which was used to keep the people warm when temperatures dropped, light their way in the dark, cook their food, and toughen the tips of their wooden hunting spears.

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How does a water pistol work?

SCIENCE AND TECHNOLOGY

1. With water pressure
2. With compressed air
3. With heat pressure

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Water Pressure

Water pressure exerts force. It can send things "down the drain," and it can shoot a stream of water from a toy pistol.

1 It's water pressure that makes a water pistol work.

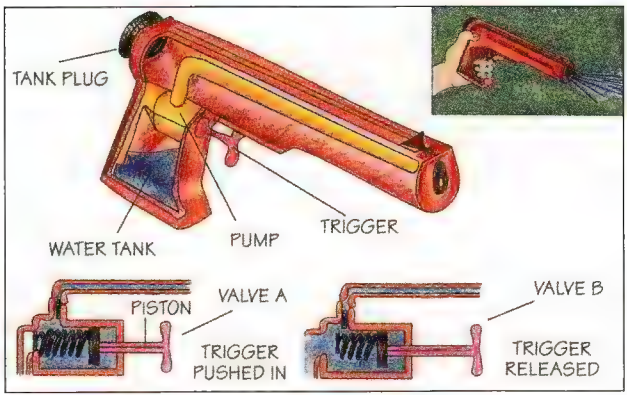

Illustration by Mina Perrotti

Pistol loaded with water—A: with trigger pressed; B: with trigger released.

The handle of a water pistol serves as a tank to hold the water supply. A flexible hose connects the tank to a pump that's worked by pulling a trigger.

Pull and Release

If someone pulls the trigger it releases a spring that opens access to the water supply. The water that was in the pump is sent toward the opening on the front of the gun. By releasing the trigger, the valve closes and there's no access to the gun's pump. But the water in the tank returns toward the pump, ready for the next squirt.

The smaller the opening in the front of the gun barrel, the further the water squirts. Why? Because the water is held "captive" and can't move freely, pressure builds. When the trigger's pulled, water that squeezes through the tiny opening is shot forward by the extreme pressure behind it!

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What is oil?

SCIENCE AND TECHNOLOGY

1. Liquid gold
2. A natural mineral lubricant
3. Liquid rock

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Oil

Oil is the result of millions of years of heat and pressure on the remains of decayed plant and animal life. What began as prehistoric life provides energy for people today.

2 Oil is a natural mineral lubricant.

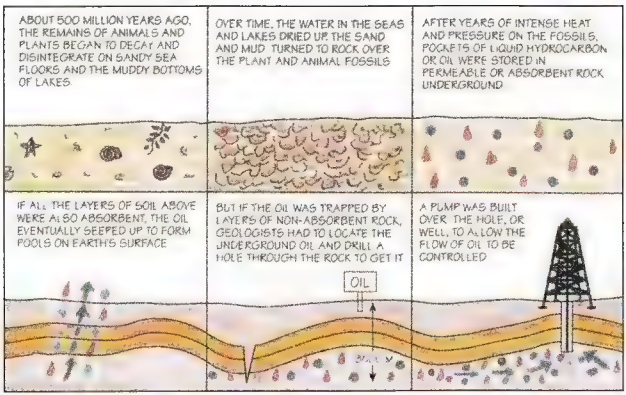
ABOUT 500 MILLION YEARS AGO, THE REMAINS OF ANIMALS AND PLANTS BEGAN TO DECAY AND DISINTEGRATE ON SANDY SEA FLOORS AND THE MUDDY BOTTOMS OF LAKES
OVER TIME, THE WATER IN THE SEAS AND LAKES DRIED UP. THE SAND AND MUD TURNED TO ROCK OVER THE PLANT AND ANIMAL FOSSILS
AFTER YEARS OF INTENSE HEAT AND PRESSURE ON THE FOSSILS, POCKETS OF LIQUID HYDROCARBON OR OIL WERE STORED IN PERMEABLE OR ABSORBENT ROCK UNDERGROUND
IF ALL THE LAYERS OF SOIL ABOVE WERE ALSO ABSORBENT, THE OIL EVENTUALLY SEEPED UP TO FORM POOLS ON EARTH'S SURFACE
BUT IF THE OIL WAS TRAPPED BY LAYERS OF NON-ABSORBENT ROCK, GEOLOGISTS HAD TO LOCATE THE UNDERGROUND OIL AND DRILL A HOLE THROUGH THE ROCK TO GET IT
OIL
A PUMP WAS BUILT OVER THE HOLE, OR WELL, TO ALLOW THE FLOW OF OIL TO BE CONTROLLED

Illustration by Mimi Perrotti

Oil we use today originated as the decayed remains of prehistoric plants and animals.

Millions of years ago, decaying plant and animal life sank into mud and sand at the bottom of the sea. The fossils became hydrocarbons—hydrogen from the water and carbon from living matter. Later the seas dried up, trapping the hydrocarbons in layers of rock as pockets of oil.

Flammable Fossils

In time, some oil seeped to Earth's surface in pools. People discovered the black liquid was flammable and could be used as fuel. Geologists sank pipes into underground pockets of oil and brought it to the surface in wells. Oil was so important it was called "black gold." Today, thousands of products, including paints and plastic, are made from oil. Experts warn we should conserve fossil fuel because it can't be replaced...unless we want to wait another 500-million years for it!

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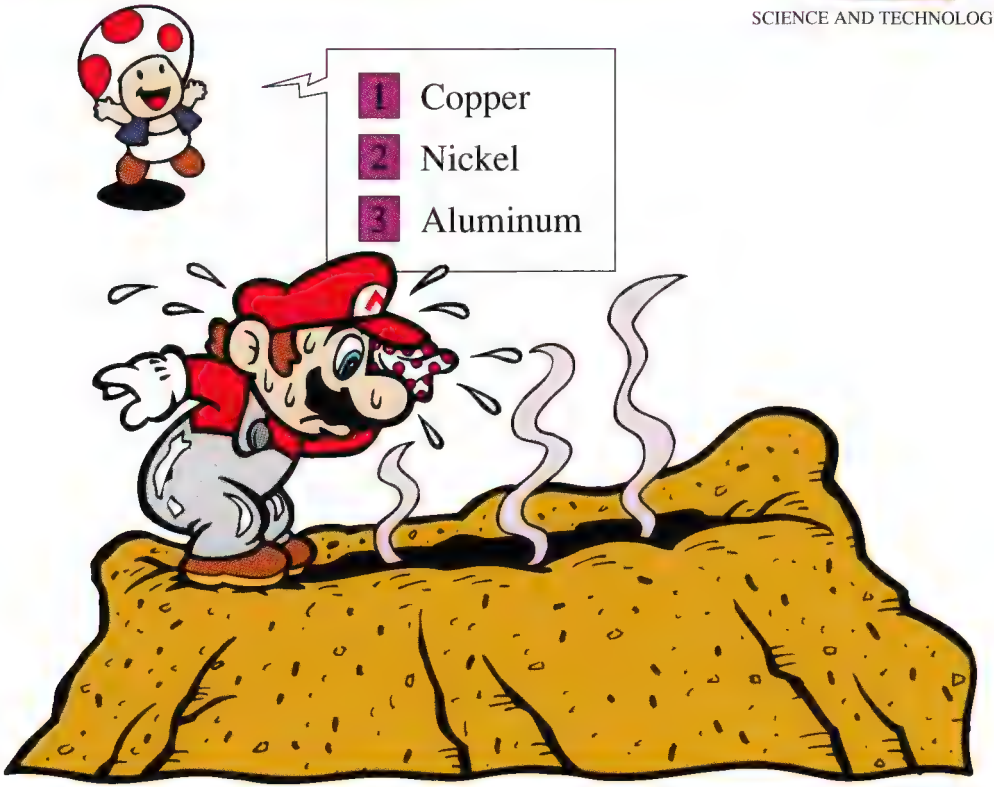
Which metal covers the overalls of volcano scientists?

SCIENCE AND TECHNOLOGY



©1995 Nintendo

Aluminum

Volcanologists working near lava flows wear overalls covered with aluminum coating. The aluminum reflects the lava's heat away from the scientists' bodies.

3 **The scientists' overalls are covered with aluminum.**

Photo © Kraft/Explorer

Aluminum weighs three times less than iron. After iron, it's the metal most used in planes, cars, electrical tooling, kitchen utensils, etc.

Aluminum is a silvery-white metal. About 8 percent of Earth's crust is comprised of aluminum, making it the most abundant metal on our planet.

Alloys

Too soft in its pure state for most uses, aluminum is used in industry in numerous alloys or metal mixtures. It may be combined with copper, zinc, manganese, or other metals, depending on what special qualities are desired.

Many Uses

Aluminum is lightweight, conducts electricity well, resists corrosion by air or seawater, and reflects light and heat well. So aluminum is the metal of choice for many items, including cars, planes, eating and cooking utensils, bikes, and outdoor furniture.

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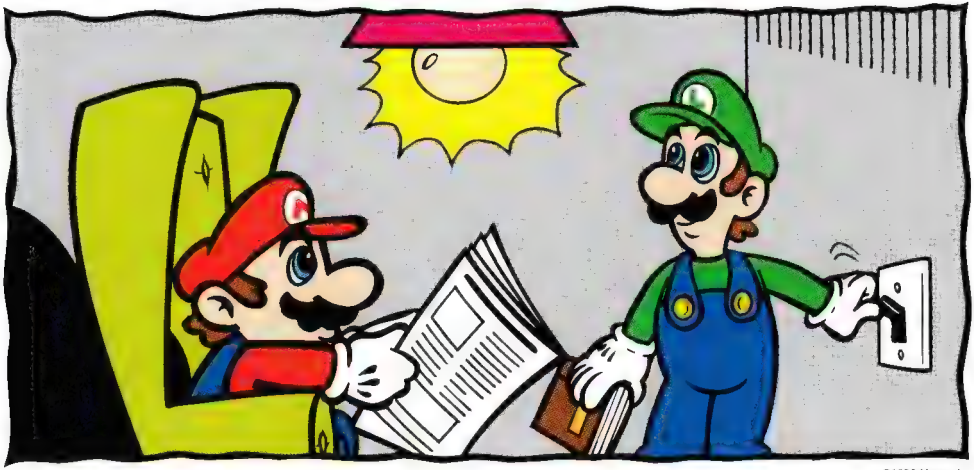
How does a light bulb work?

SCIENCE AND TECHNOLOGY

1. Electric current passes through the bulb's filament
2. Electric current fills the bulb like air in a balloon



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Light Bulb

Electricity coming into a house supplies a steady flow of power or current. When a lamp is switched on, current is allowed to pass through the thin, coiled wire or filament of the bulb to generate light.

1 Electric current passes through the filament of a bulb to light it.

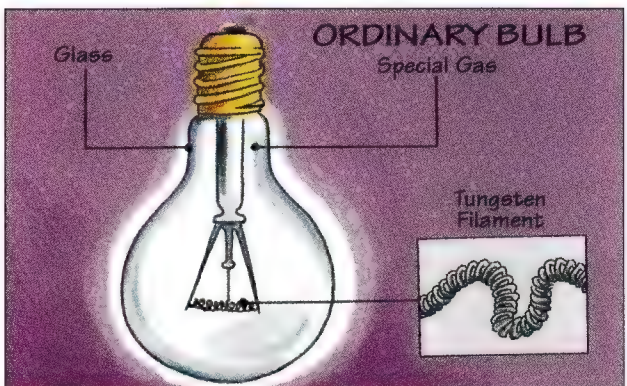

Illustration © Y Tabuchi

Have you ever shaken and listened to a burned-out light bulb? What do you think makes the noise inside?

An electric light bulb has a thin coiled filament of tungsten sealed within the glass bulb. Electricity passing through the tungsten heats it to more than 4,500° F (2,482° C). This extremely high temperature makes the filament give off light. Luckily, tungsten can withstand such high temperatures without melting!

No Air in There

Air must be kept away from the tungsten filament to prevent it from burning up. So there is no air inside a light bulb. Air originally inside the glass bulb was pumped out and replaced with an inactive gas, like argon or nitrogen. These gases prevent electricity from jumping around inside the bulb. The inside of the glass may also be coated to diffuse or scatter the light and reduce glare.

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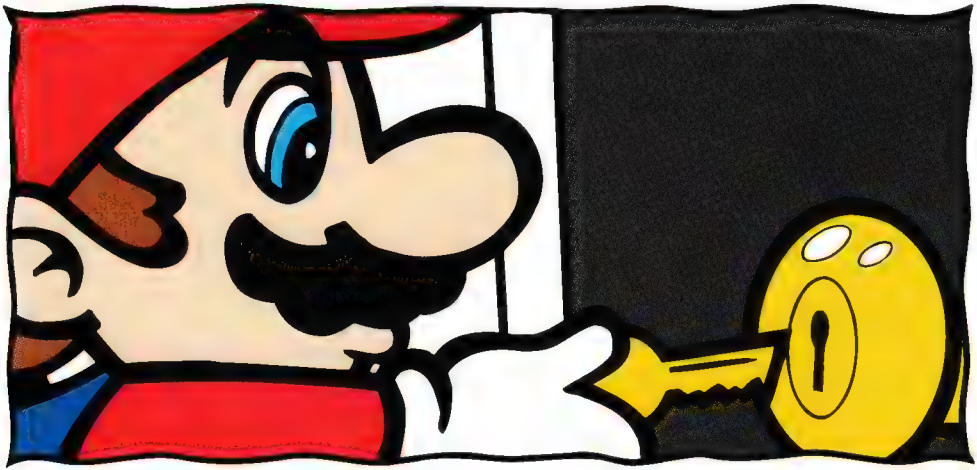
D3 054 08-14

How does a key open a lock?

SCIENCE AND TECHNOLOGY

1. The key turns some bolts in the lock
2. The notches of the key align with pins in the cylinder



©1995 Nintendo

Lock and Key

When you turn a key in a lock, its notches act like wedges that push against spring pins in the drum or cylinder to move the bolt.

2 **For a key to open a lock, it must have notches that align with pins in the cylinder.**

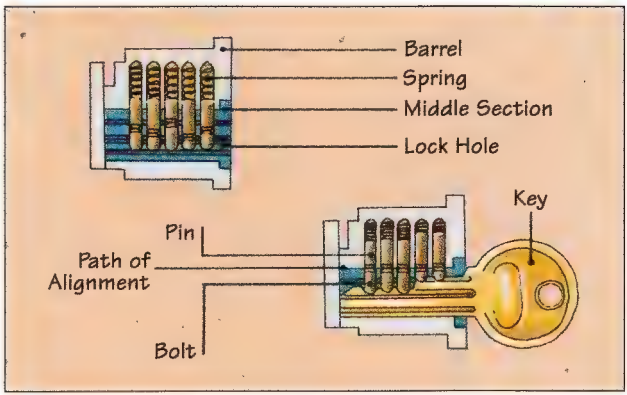


Illustration © Y. Tabarés

Diagram of a lock in the closed position (top) and open (bottom).

Look at the top diagram of a closed lock. You'll notice that each spring pin or tumbler is in place to block access to the bolt.

Insert Key

In the bottom diagram, the key has been pushed into the opening of the lock. Notice that the key's notches force up the spring pins that keep the lock shut. This enables the key to turn and activate the cam—the metal piece that controls movement of the bolt. When the cam turns, the lock opens.

The Perfect Match

A lock will open only if you use the key whose notches align with the lock's tumblers. The first lock-and-key was invented in Egypt around 2000 B.C. A large wooden bolt was fastened to the outside of a gate. Pegs were inserted into holes in the bolt to prevent it from being moved. Only a grooved key could raise the pegs so the bolt could be moved and the gate opened.

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In which forest area do people collect latex?

SCIENCE AND TECHNOLOGY

1. Sherwood forest
2. Redwood forest
3. Amazon forest

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Latex

In the Amazon forest of northern Brazil, tappers collect latex, the sap that flows from the hevea trees. After the latex has been processed, it turns into balls of rubber.

People in the Amazon forest collect latex from hevea trees.

Photo © Edouard / Explorer

The smoked latex gives off an offensive odor, but this is a necessary step in processing the liquid into rubber.

Hevea trees are the source of latex, which is one-third rubber. The trees grow in an area known as the "rubber belt," 700 miles (1,100 km) on either side of the equator.

Collecting Latex

To get the milky-white latex from each hevea tree, a tapper cuts a diagonal groove in the bark 4 feet (1.2 m) above the ground. Then a U-shaped metal spill cup is attached to the bottom of the cut to catch the latex that oozes out. This liquid—the source of natural rubber—must be processed within several hours or it decomposes. So it's thinned with water and acid and smoked to make it coagulate—form solid balls. The smoking kills any bacteria and mold. Then the rubber is rolled into sheets, dried, and shipped to a rubber manufacturer, where it could end up as tires on your bike!

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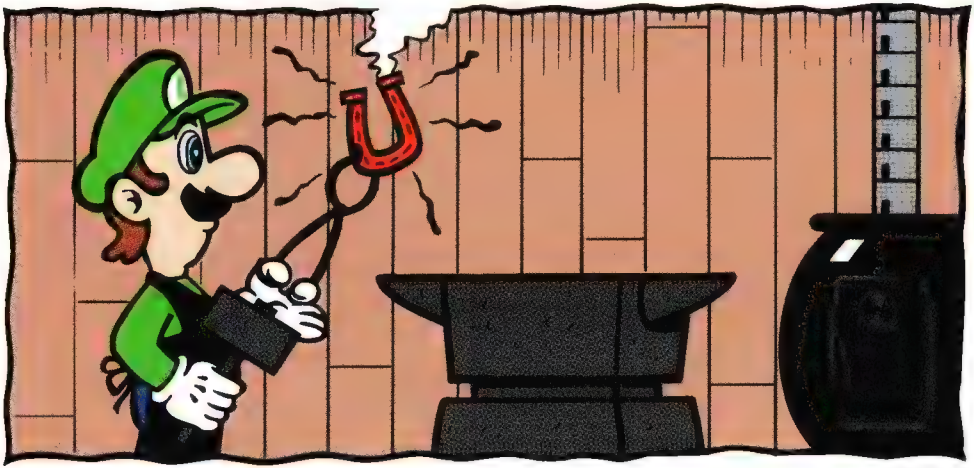
D3 054 09-05

How long have humans worked with iron?

SCIENCE AND TECHNOLOGY

1. For about 10,000 years
2. For about 3,000 years
3. For about 100 years



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Iron

About 3,000 years ago, Hittites living in the Middle East learned to work with iron.

2 Humans first began to work with iron about 3,000 years ago.

Photo © Ernath / Explorer

The red-hot metal must be hammered repeatedly to shape it. Here a blacksmith prepares a shoe for a horse.

Iron melts at very high heat—around 2,732° F (1,500° C). So it was impossible to separate the metal from its ore until the invention of the low furnace. This type of oven was dug into the ground, where it could be heated to extremely high temperatures.

The Blacksmith

When extracted from ore, iron contains many impurities. To remove these, and to prepare to shape the metal, a blacksmith heats the iron in an open fire or forge. When the metal has become red hot, the blacksmith hammers it repeatedly on an anvil. The blacksmith puts the metal back into the forge again, if necessary, and continues to hammer it until he has just the right shape. Today, most blacksmithing is done in factories. There, iron and other metals are forged between two giant dies that drop or press the metal into shapes.

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D3 054 09-12

Where was the first oil well drilled?

SCIENCE AND TECHNOLOGY

1. In Saudi Arabia
2. In Mexico
3. In the United States

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Oil Well

Colonel Edwin Drake drilled the first commercially successful oil well near Titusville, Pennsylvania in 1859. That started a rush for oil or "black gold."

The first oil well was drilled in the United States.

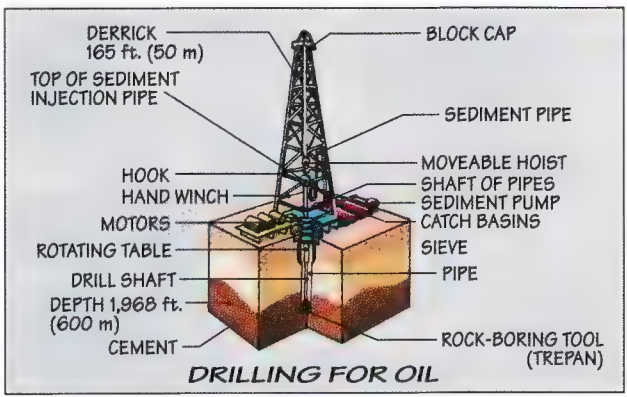

Illustration © Y. Tabarés

Derrick above an oil-well shaft. Shafts may reach depths of 6,760-9,840 ft. (2,000-3,000 m); some as far down as 49,200 ft. (15,000 m).

American Edwin Drake's oil well was profitable. He succeeded in drawing out, with the help of steel tubes placed end-to-end, more than 3.3 tons (3 metric tons) of oil per day.

The Derrick

Underground, in layers of rock and soil, pockets of oil sit on a layer of gas that floats on a bed of salt water. To reclaim the oil, workers first determine its location, then drill a well to extract it. A derrick, or tower, is constructed above the well site. Attached to the derrick is a rock-boring tool, called a trepan, which looks like an enormous steel wheel. It sinks a bit into the ground, grinds the rock, and positions hollow pipes in the hole. The pressure of the gas causes the oil to gush up to the surface through the pipes. Gas that escapes with the oil is burned off to avoid an accident.

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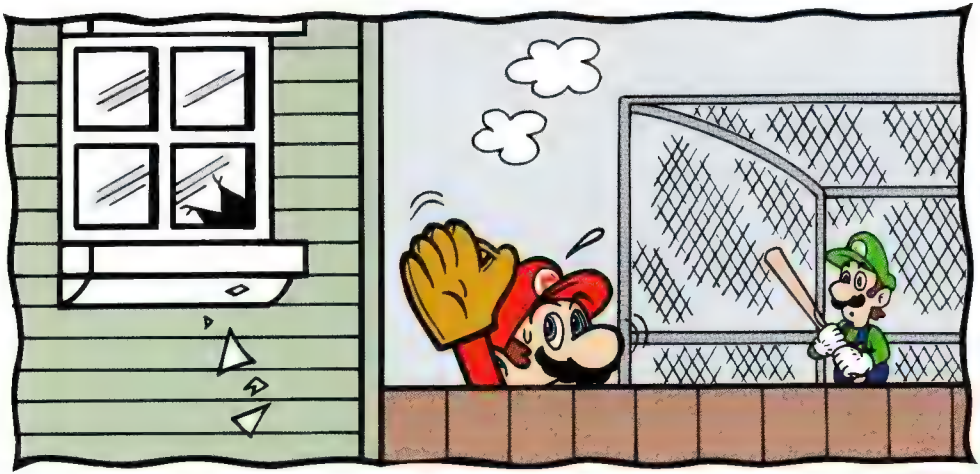
Is glass always fragile?

SCIENCE AND TECHNOLOGY

1. No, some glass is treated to resist shock, impact, and heat.
2. Yes, all glass is fragile.



©1995 Nintendo

Glass

Glass is the result of combining—at high temperature—a mixture that includes, among other things, silica and lime. The mixture is then merged into a liquid paste and formed into shapes before it cools.

1 Some glass is treated to resist shock, impact, and heat.

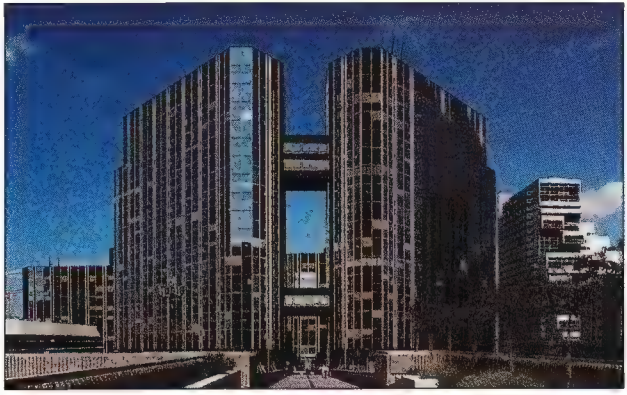


Photo © Bobin / Explorer

Modern techniques of making glass strong, heat-resistant, and shatterproof allow the construction of buildings like this to reflect the panoramic view of a city.

Glass may be shaped in several ways, including blowing into the hot, glass through a pipe or pouring the glass into casts. Most glass is treated to make it stronger. Airplane windows are treated so they don't explode from changes in air pressure. Some dishes are treated so you can put them into an oven, microwave, or freezer. Some glass is even tough enough to stop bullets!

Treating Glass

Glass is treated, or annealed, by heating it, then cooling it slowly to remove internal pressure that might cause sudden cracks or breaks. Tempered glass—heated until it's almost soft, then chilled quickly by a blast of cold air—is five times as hard as ordinary glass.

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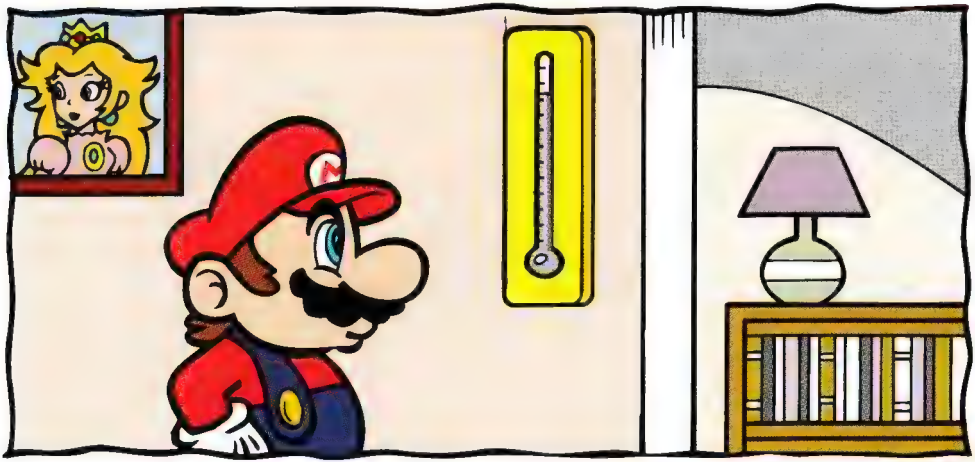
D3 054 10-07

What metal is liquid at room temperature?

SCIENCE AND TECHNOLOGY

1. Iron
2. Gold
3. Mercury



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Metal

All metals are solid at room temperature, except mercury—the shiny liquid metal used in thermometers. It flows so easily and rapidly that it's called "quicksilver."

3 Mercury is the only metal that's liquid at room temperature.

Photo © Plisson / Explorer

Foundry workers pour the hot molten metals into casts.

Metals like gold, silver, and copper, are found in their natural state as ore in the ground. But most metals are alloys, or combinations of ores. The science and technology of metals and alloys is called metallurgy.

Melting Metal

Heat melts metal—the temperature at which it melts varies with each metal. For example: Gallium, a rare metal used in semiconductors, melts like butter; tin melts at 448° F (231° C); aluminum at 1,220° F (660° C); and iron at 2,732° F (1,500° C). Mercury, named for the swift messenger in Roman mythology, already exists in a liquid state. When mercury is mixed with other metals, it forms alloys called amalgams. A mixture of mercury and silver create an amalgam dentists use to fill cavities in teeth.

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Which is used to transport oil from wells to the refinery?

SCIENCE AND TECHNOLOGY

1. Planes
2. Pipelines
3. Wagons

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Pipeline

Crude oil is pumped from a well into a pipeline. Pumps keep it flowing to storage, other carriers, or directly to the refinery.

2 Oil is transported from wells to refineries by pipeline.

Photo © Borredon / Explorer

These pipelines bring oil from wells to a harbor where it can be pumped into a giant tanker for export.

A pipeline makes it possible for oil to be transported from the well to its destination—a refinery, storage tank or carrier.

Giant Pipelines

Pipelines are a series of welded tubes, each several feet (meters) long and about 3 feet (1 m) in diameter. The largest pipelines can carry more than a million barrels of oil per day over all kinds of terrain. The Trans-Alaska Pipeline crosses three mountain ranges, more than 300 rivers and streams, and nearly 400 miles (640 km) of frozen land. Pipelines are costly to build but inexpensive to operate. They are the most efficient means of moving petroleum. Bury-ing the pipes underground is preferable for the environment, but it's not always possible, especially in polar regions where the soil is frozen most of the year.

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What is soap made of?

SCIENCE AND TECHNOLOGY

1. Fats and chemical alkalis
2. Clay and oil
3. Powder, chalk, and flowers

©1995 Nintendo

Soap

Soap is basically a blend of fat and alkali. The fat may come from animals or from vegetable oils like palm, coconut, or olive. Soap has lathering and detergent or cleaning abilities.

1 Soap is made of fats and chemicals called alkalis.

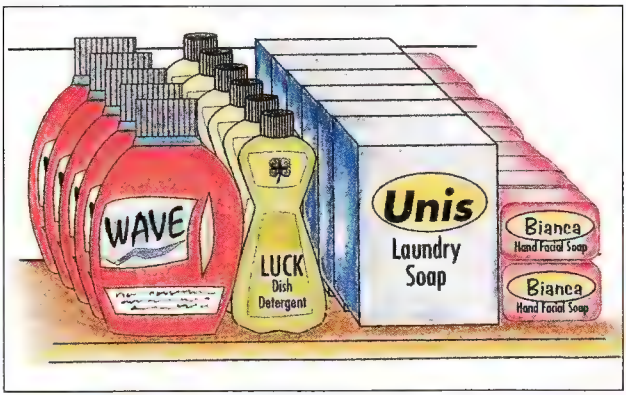

Illustration © Manni Perrotti

Soap comes in different forms and with different added ingredients.

People use soaps to clean themselves, their clothing, and their homes. The average person uses 30.5 pounds (14 kg) of sudsy cleansers a year in the form of bars, flakes, granules, and liquids.

Making Soap

To transform animal or vegetable fat that's insoluble in water into soap that's water soluble, it must be blended with an alkaline material such as potassium hydroxide. This mixture is heated for hours to trigger a chemical reaction that forms a creamy soap that rises to the top. The soap is placed in a huge mixer called a crutcher, where other ingredients like perfume, color, or germ killers, are added, depending upon the intended use of the product. Then the soap can be used as-is, hardened into bars, or made into flakes and granules.

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D3 054 11-09

What makes a match light?

SCIENCE AND TECHNOLOGY

1. Friction caused when the paper or wooden stem is scratched on any rough surface
2. Friction caused when the match head is scratched on a rough or specially treated surface

©1995 Nintendo

Matches

Matches were invented in the early 1800s. They provided a convenient, inexpensive way to produce fire.

2 **Friction of a match head against a rough or specially treated surface causes the match to burst into flame.**

Photo © Ph. DeRoy / Explorer

Though colorful and interesting, matches can be dangerous. Never play with matches.

Some matches have paper stems; some have wooden stems. Both have tops, or heads, coated with a chemical. When the head is rubbed against a rough or specially prepared surface, the chemical bursts into flames and ignites the paper or wood stem.

The "Eyes" Have It

A strike-anywhere match head has a white "eye" made of phosphorus. It bursts into flames when scratched against any rough surface. As the "eye" fires, it sets the rest of the bulblike head on fire. These matches are dipped in paraffin that carries flame from the head to the wooden stem.

Safety Matches

A safety match head is coated with chlorate of potash that burns at 360° F (182° C). It ignites when scratched on a special surface coated with red phosphorus and sand.

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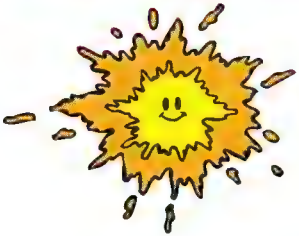
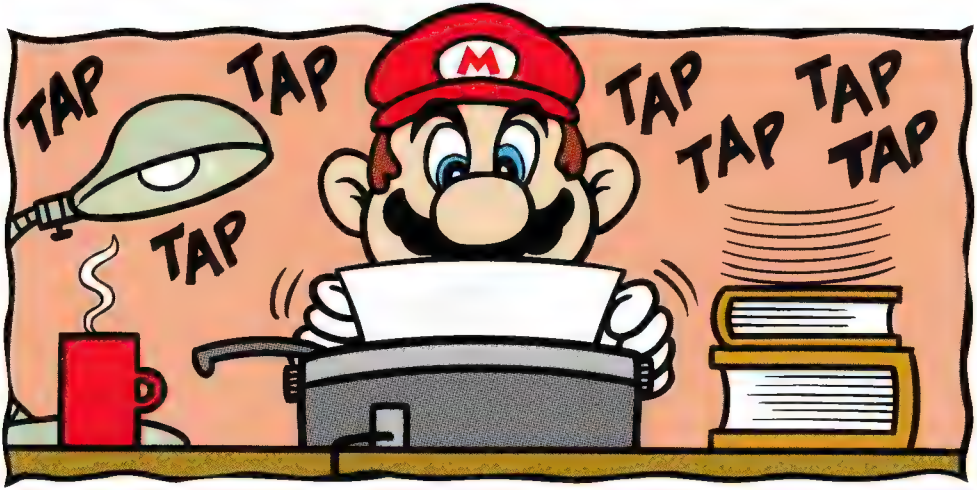
When was the typewriter invented?

SCIENCE AND TECHNOLOGY



1. In 1960
2. In 1923
3. In 1867



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Typewriters

In 1867, the first practical typewriter was built by C.L. Sholes, C. Glidden, and S.W. Soulé. It was patented in 1868, and by 1873 Remington and Sons, the gun makers, made the first commercial typewriters.

3 The typewriter was invented in 1867.

Typewriters saved lots of time for people who previously wrote everything by hand. Today's word processors do the work even faster.

Keys and Characters

Mechanical typewriters all work on the same principle: each key is attached to a different metal bar on which are raised letters or symbols. By striking a key, as on a piano, the metal bar lifts forward, hits an inked ribbon, and prints the letter or symbol on a piece of paper held in the machine by a roller. When the metal bar returns downward, the typewriter's carriage moves to the left the width of one printed letter. When a full line has been printed, a lever allows the typist to move the carriage to the right and turn the paper's roller to start a new line.

Electric Age

In the mid 1930s, the first electric typewriters appeared. In the 1960s came the use of computers and word processors.

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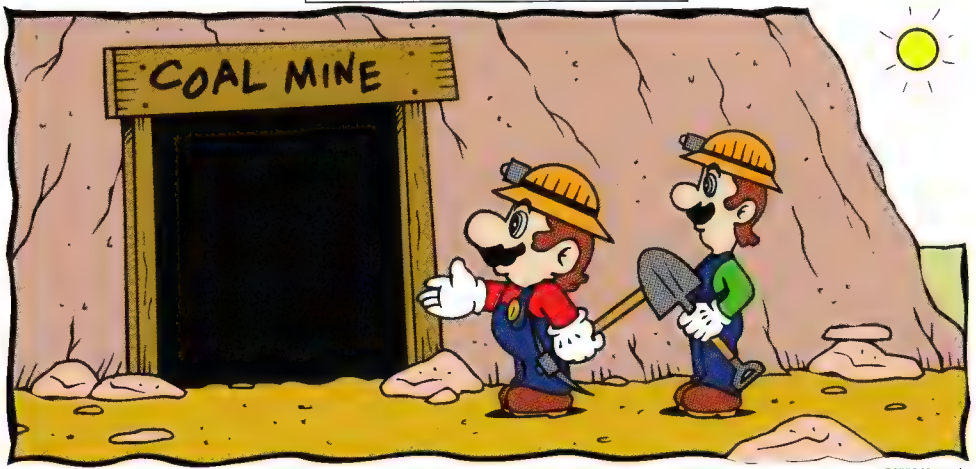
D3 054 12-19

Which of these are types of coal mines?

SCIENCE AND TECHNOLOGY

1. Strip mine
2. Drift mine
3. Slope mine
4. All of the above



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Coal Mines

There are two kinds of coal mines: surface and underground. Most surface mines are strip mines—coal is dug by gouging away the land around it. Underground mines are either shaft, slope, or drift types.

4 Strip, drift, and slope are all types of coal mines.

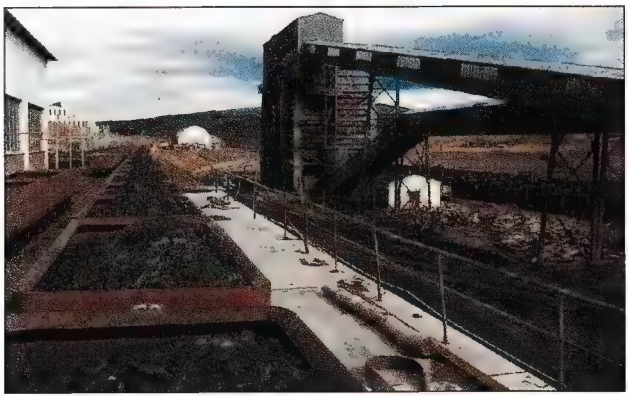

Photo © F. Gohier / Explorer

From a mine, coal is loaded on conveyors and brought to the panning site, where the pieces are sorted by size.

Strip mining is usually limited to coal deposits 100-200 feet (30-61 m) below Earth's surface. Giant machines peel away rock and soil covering the coal, removing up to 3,500 tons (3,180 metric tons) per hour. Deeper deposits are mined underground.

Modern Mines

When underground mining began, workers knocked coal out of the rock walls with picks, shoveled it into baskets, and brought it up to the surface. Today things are mechanized. Human workers still do some work and supervise progress, but huge machines dig, load, and haul the coal. In shaft mines, entrance and exit passages are vertical. Slope mine passages slant downward. And drift mine passages are dug horizontally into a visible coal bed on the side of a hill.

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D3 054 12-20

How does a doorbell work?

SCIENCE AND TECHNOLOGY

1. Air pressure makes the bell ring.
2. An electric current makes the bell ring.
3. A buzzer triggers a tape-recorded bell sound.

©1995 Nintendo

Doorbells

A doorbell is the most common type of electric bell. Vibrations, caused by a circuit of electric current, make a metal clapper hit the bell.

2 Electric current makes a doorbell ring.

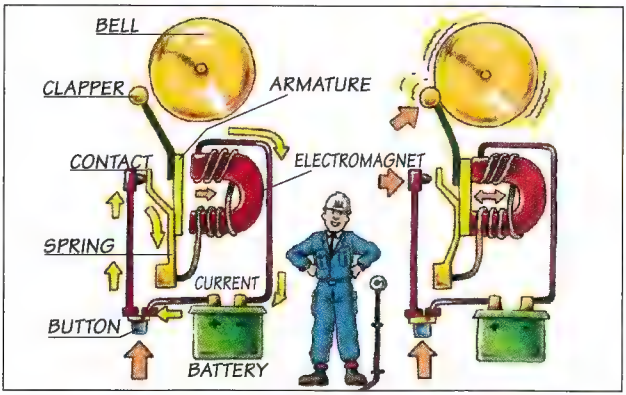

Illustration © Y Tabaré

These diagrams show how electric current flows from a power source (battery) to ring the doorbell.

A doorbell's electric current is created by the attraction between an electromagnet and metal parts in the mechanism. Wires connect the doorbell's button to the current that operates the bell. One wire goes from the power source—a battery or electric power line—to the electromagnet, an armature with a metal clapper, and a spring. The spring presses against a contact, from which a second wire leads back to the power source. When someone presses the doorbell button, current travels along the wire to the electromagnet, attracting the armature and causing it to vibrate. The vibrations make the clapper hit the bell.

Circle of Current

If no one pushes the button, the bell's electrical circuit is interrupted. But as soon as someone pushes the button, the circuit is complete and the bell rings again. (Is that your doorbell ringing now?)

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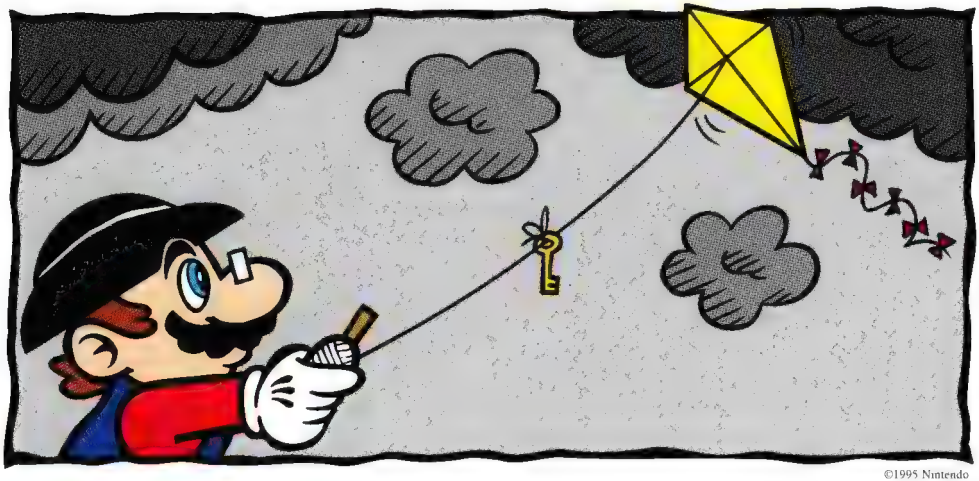
D3 054 14-01

What is electricity?

SCIENCE AND TECHNOLOGY

1. A flow of the sun's rays
2. A form of energy
3. A glowing wave



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Electricity

Electricity is one of the most important forms of energy. It can produce light and heat and provide power to run machines at home, in school, and at work.

2 Electricity is one form of energy.

Photo © Arhus-Bertrand / Explorer

High-tension wires are strung between pylons. Pieces of non-conducting porcelain help channel the electricity to its destination.

Electricity's force is created by the flow of tiny particles called electrons. They're so small you can't see them—even with a microscope. As electrons move along wires, they form an electric current.

Providing Electricity

Electricity is produced at power plants by large machines called generators. From there, the electricity travels to smaller substations along high-tension wires that are strung from tall metal pylons. The electricity in these wires contains about 230,000 volts—much too powerful for household use. The wires carry electricity through a transformer, where the voltage is lowered to 120 or 220 volts. Then it goes by overhead wires or underground cables to homes, schools, farms, and anywhere else people need power. At each destination, the electricity flows through a meter that keeps a record of how much power is used.

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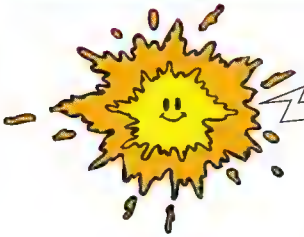
D3 054 14-05

What is solar energy?

SCIENCE AND TECHNOLOGY



1. Energy supplied by the sun's rays
2. Energy supplied by Earth's magnetic core
3. Energy supplied by the sea

©1995 Nintendo

Solar Energy

Our sun gives off 13 million times more energy in one second than all the electricity used in the U.S. in a year. That energy can be harnessed for use.

Solar energy is supplied by the sun's rays.

Photo © N. Thibault / Explorer

Rooftop solar collectors supply energy to these buildings.

Solar collectors harness the sun's energy. They usually consist of black heat-absorbing panels with attached tubes. Water or air circulating through the tubes collects the heat and that energy is used to run space heaters and air conditioning units.

Solar Furnaces

Hundreds of mirrors that focus the sun's rays are used in solar furnaces. The intense heat energy produced is used for everything from cooking to powering engines that in turn generate electricity. Experts propose putting a giant solar reflector in space to harness the sun's power and beam it down to Earth in microwaves! Experiment with solar energy yourself. Put a hot dog on a piece of aluminum foil. Cover cardboard with another piece of foil and prop it up to focuses the sun's rays directly on the hot dog. Wait for the food to heat…then eat!

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D3 054 15-19

How do we measure temperature?

SCIENCE AND TECHNOLOGY

1. By degrees Celsius (°C)
2. By degrees Fahrenheit (°F)
3. By either or both of the above

©1995 Nintendo

Temperature

Temperature, the degree of hotness or coldness of an object, can be measured with a thermometer.

We measure temperature by either degrees Celsius (°C) or Fahrenheit (°F), or by both.

Photo © J. Thomas / Explorer

The atoms and molecules in a burning object move at an extremely fast rate, so the temperature is high and the heat intense.

Measuring by Degrees

The most common kind of thermometer has a clear, hollow tube with a liquid at the bottom. The liquid is either mercury—a liquid metal—or alcohol mixed with red dye. When the liquid heats, it expands and rises in the tube. As the liquid cools, it contracts and drops lower in the tube. The numbers along the side of a thermometer indicate the temperature in degrees, using either the Fahrenheit scale (°F), the metric Celsius scale (°C), or both. Most countries use metric measurements for everything, but the U.S. doesn't. Here, temperatures are frequently given in both so everyone can understand. Examples of Fahrenheit/Celsius equivalencies include: the normal temperature of the human body is 98.6°F or 37°C, water freezes at 32°F or 0°C, and water boils at 212°F or 100°C.

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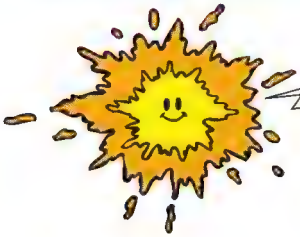
D3 054 16-09

Which are used to make concrete?

SCIENCE AND TECHNOLOGY



1. Stones and lime
2. Sand, gravel, cement, and water
3. Ground brick and cement

©1995 Nintendo

Concrete

Concrete, a mixture of water, sand, gravel, and cement, is an important construction material. Concrete is used to make bridges, roads, buildings, sewer pipes, and more.

2 Concrete is made from sand, gravel, cement, and water.

Photo © Mark Segal / Tony Stone Worldwide

The part of a truck that carries cement, a fine gray powder, and the other ingredients to make concrete, constantly moves so the mixture won't harden before it's spread on the ground.

Concrete is watertight, fire-resistant, and relatively inexpensive to make. The water and cement, a fine gray powder, form a paste that bonds the other ingredients as the concrete hardens so it can withstand great pressure. When first mixed, it can be molded into just about any shape. It quickly hardens into a very hard material that requires little care.

Strengthening Concrete

Most factories and skyscrapers stand on concrete foundations and have concrete floors and walls. Airplanes take off and land on concrete runways. To reinforce concrete used for skyscrapers and bridges, it is cast around steel bars. Concrete for runways and roads has tiny air bubbles that allow the water in concrete to expand as it freezes. The bubbles are formed by adding soaplike fatty material to the concrete when it's mixed.

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D3 054 16-11

What is acoustics?

SCIENCE AND TECHNOLOGY

1. The study of gymnastics
2. The study of sound
3. The study of plants

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Acoustics

Acoustics is the study of sound and its effect on people. This includes controlling noise pollution as well as providing proper conditions for producing and listening to sound.

Acoustics is the study of sound.

© F. Jalain / Explorer

Concert halls and auditoriums are built and decorated to enhance the acoustical quality of sound.

Inside a cave or a tunnel, a whisper can echo loudly throughout the space. There's nothing on the smooth hard walls, floor, and ceiling to absorb or cushion the sound, so it just keeps reverberating or bouncing around. Eventually it becomes distorted and unpleasant to hear. When theaters and concert halls are built, they're very much like vast empty caverns. That's where acoustics comes in.

Making Sound Just Right

To make it pleasing to listen to music or speech in concert halls and theaters, acoustics experts control reverberation. Some reverberation is necessary for an agreeable sound, but too much blurs the sounds of voices and musical instruments. So sound-absorbing objects, such as acoustical wall and ceiling tiles, carpeting, drapes, and upholstered furniture, are positioned to control the amount of reverberation.

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D3 054 17-17

When was the zipper invented?

SCIENCE AND TECHNOLOGY

1. 1900s
2. 1700s
3. 1500s

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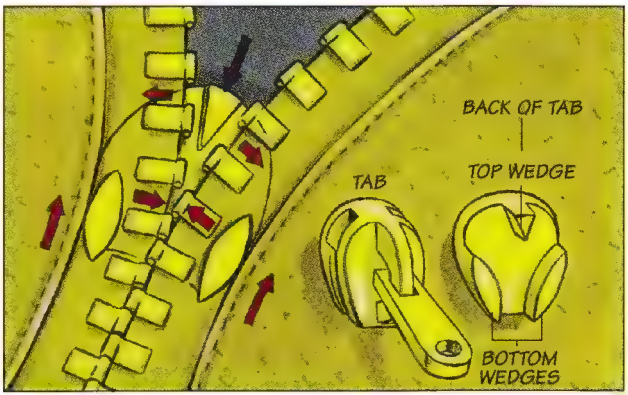
Zipper

The toothed slide fastener we use today was invented in 1913 by Gideon Sundback of Pennsylvania. In 1923, B. F. Goodrich used them on galoshes, calling them the "Zipper."

1 The zipper was invented in the 1900s.



© Y. Tabares

A zipper pulls the "teeth" into the hollows. This small invention makes a big difference in our daily lives!

In 1893, Whitcomb Judson made a slide fastener that attached a series of hooks and eyes. But the zipper we use today has two rows of teeth, each on the edge of a separate strip of fabric. The teeth are positioned opposite hollows, or openings. As you pull the zipper tab upward, the edges of fabric are drawn together, meshing the teeth snugly into the hollows. The zipper remains fastened until you pull the tab in the opposite direction, unmeshing the teeth.

Various Uses

Zippers were first used in men's pants. Women's fashions first included zippers instead of buttons or hooks and eyes in the late 1920's. Today, zippers are used on luggage and handbags, tents and sleeping bags, toys, and clothing for the whole family.

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Who first raised silkworms to produce silk for making clothes?

SCIENCE AND TECHNOLOGY

1. The Japanese
2. The Africans
3. The Chinese

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Silkworms

Silkworms are actually caterpillars which feed on mulberry leaves. They spin thick silky cocoons made of a single thread about 2,950 feet (900 m) long.

3 The Chinese were the first to raise silkworms to produce silk for clothing.

© J. Thomas / Explorer

The silkworm moth, after it has emerged from its cocoon.

In 2700 B.C., Xilingshi, the wife of Chinese Emperor Huangdi, discovered that a silkworm's cocoon could be unraveled into a single silk thread. The thread, she decided, could be woven into clothing. For centuries, only the Chinese knew how to produce silk threads, but today most silk comes from Japan.

Growing Silk

As silkworms mature, they weave cocoons by secreting a liquid that, when dried, becomes a single silky thread. Before the pupa inside each cocoon can go through metamorphosis to become a moth, it's placed in a bath of scalding water. This kills the pupa and softens the cocoon. Then each cocoon is unwound and the silk thread dried, dyed, and woven into cloth. Silk, the strongest of all natural fibers, makes clothing that is lightweight but warm.

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D3 054 18-13

Which are important components of wood?

SCIENCE AND TECHNOLOGY

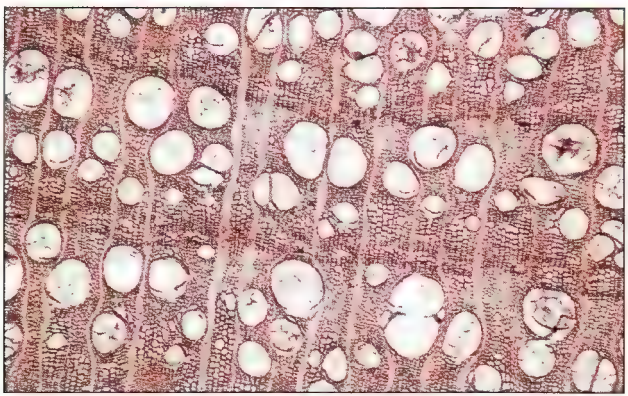
1. Lanolin and aloe
2. Cellulose and lignin
3. Amalgums and wingtips

©1995 Nintendo

Wood

Wood consists largely of cellulose and lignin, a tough, fibrous substance that makes wood hard. The amount of lignin varies depending on the tree species. The harder the wood, the more lignin it contains.

Cellulose and lignin are the two most important components of wood.



© C. Gautier / Jacana

Wood of the acacia under a microscope. Many plants contain cellulose but only trees provide enough for use by humans.

Each tree contains two kinds of wood: sapwood that's nearest the trunk's bark, and heartwood that's nearest the trunk's center. Sapwood is living wood, with tiny pipelines that transport sap and water throughout the tree. Heartwood dies as the tree ages and is infiltrated by oil, gums, tannins, and resins that make it dark, fragrant, and resistant to rot.

Wood Reveals History

In temperate zones, most trees grow a layer of wood each year. When a tree is cut down, the annual rings in the wood reveal its life story. You can determine the age of a tree by counting the number of rings. Narrower rings signify changes in growth. Scientists were able to date a huge volcanic eruption to the year 1625 B.C. by identifying very narrow growth rings in the wood of trees living at that time.

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DA 054 18-16

Which are used to make pottery?

SCIENCE AND TECHNOLOGY

1. Clay and sandstone
2. Quartz and limestone
3. Sand and chalk

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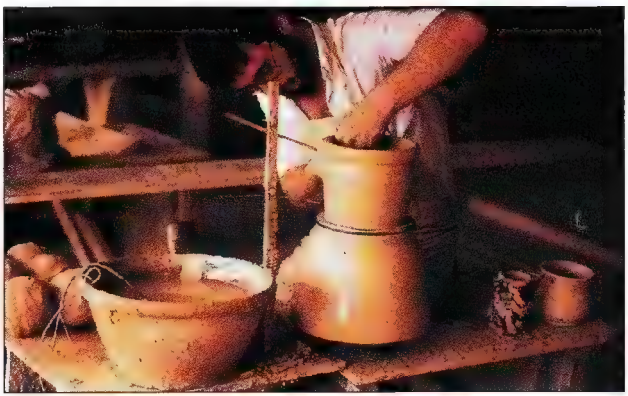
Pottery

Pottery is made from clay or sandstone—a mixture of clay and sandlike bits of quartz — then hardened by baking or firing. Earthenware, the simplest kind of pottery, has been around for thousands of years.

1 **Clay and sandstone are used to make pottery.**



© Ph. Roy / Explorer

A potter shapes an object as the clay turns on the potter's wheel. Water is constantly added to the clay to keep it soft and moldable.

At first, clay was shaped into earthenware plates and bowls, then hardened in an oven. In 3000 B.C., the Egyptians first applied glaze to their earthenware pottery. The ancient Chinese discovered that although earthenware absorbed water, stoneware —pottery made from sandstone—became waterproof when fired.

Throwing and Turning

To make pottery, water is added to clay to make it soft. Objects are shaped with the hands alone, in a mold, or on a potter's wheel—this is called throwing a pot. A potter controls the spinning potter's wheel with foot pedals while shaping the clay by hand. When complete the object is fired in a kiln at very high temperatures. Sometimes pottery is glazed and fired again.

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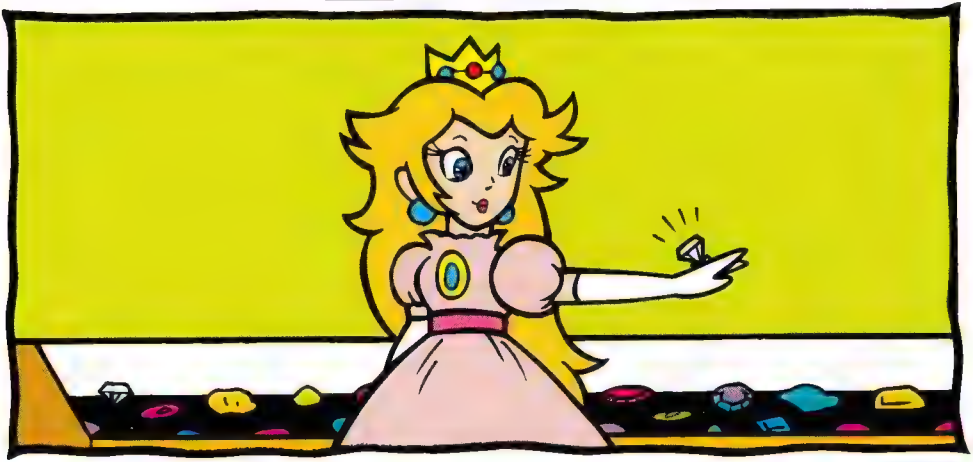
D1 054 19-10

Which are precious stones?

SCIENCE AND TECHNOLOGY

1. Diamonds
2. Emeralds
3. Rubies
4. All of the above



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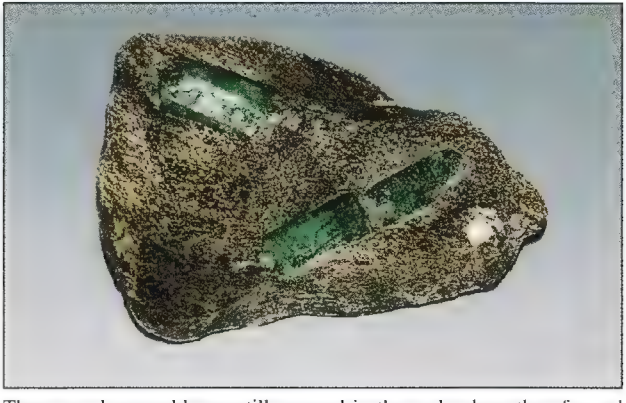
Gems

Gems are valued for their beauty, yet tough enough to be used in jewelry and ornamental art. A few, like pearls and coral, are organic—from animal or plant sources—but most are crystallized minerals, like diamonds and emeralds, found in rocks.

Diamonds, emeralds, and rubies are all precious stones, or gems.



© Novosti / Sipa Press

These rough emeralds are still encased in the rock where they formed millions of years ago. Imagine how they'll look cut and polished!

Some beautiful jewelry includes organic gems like pearls from living oysters, amber, a fossil resin from ancient trees, and jet, a fossil wood. But diamonds mined from Earth are the most prized gems, because they exceed all other gems in hardness and brilliance.

Gem Qualities

When a gem comes from a mine, it's usually rough with ân irregular shape. Skillful gem cutters cut and polish it to increase its beauty and worth. And they check to see how the stone refracts light. When light rays penetrate a perfectly cut diamond, they project the colors of the spectrum—rainbow colors.

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Which is the most precious metal?

SCIENCE AND TECHNOLOGY

1. Silver
2. Gold
3. Mercury

©1995 Nintendo

Gold

The rarity, color, and durability of gold have made it the most precious metal, valued for use in jewelry and coins.

2 Gold is the most precious metal.

© Pitcal / Sipa Press

Gold coins and ingots, or bars. Deep-sea divers often find gold coins inside ships that sank hundreds of years ago.

Gold is mined from layers of quartz and pyrite. (Iron pyrite is called "fool's gold" because it looks like gold but isn't valuable.) Gold may also be found in river-bottom sediment.

Using Gold

Pure gold is so soft it can be beaten into paper-thin sheets of gold leaf or ground into powder. In these forms gold is used in painting and decorative art. Pure gold is too soft to stand up to daily wear. So when it's made into jewelry, gold is blended with other metals, such as silver, platinum, or copper.

Counting Carats

The purity of gold in an object is measured in carats (abbreviated K) on a scale of 24. So an item labeled 24K is pure gold; 18K is 75 percent gold. Once, people carried gold coins and countries based their economies on gold. In the U.S., the value of our paper dollars is backed by gold bars the federal government keeps in Fort Knox, Kentucky.

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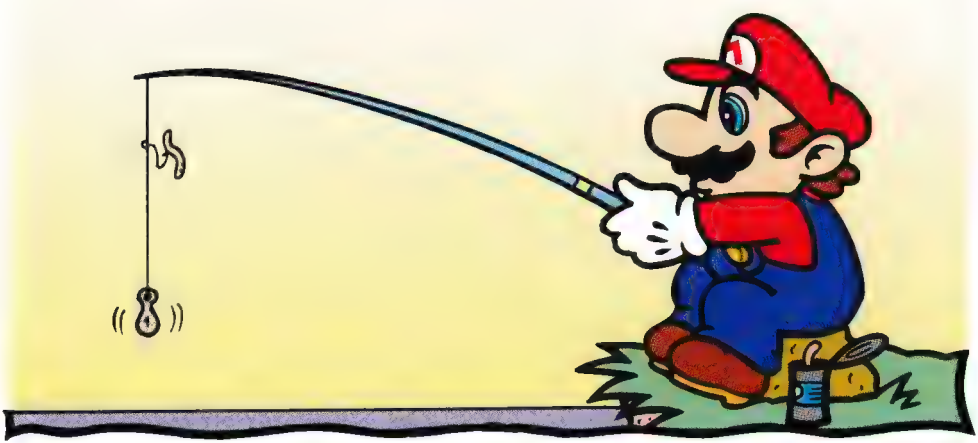
Which is a characteristic of lead?

SCIENCE AND TECHNOLOGY

1. It's soft.
2. It's golden.
3. It's seven-sided.

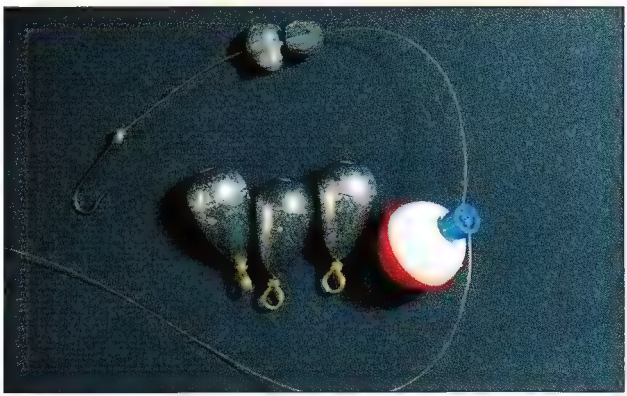


©1995 Nintendo

Lead

Lead, one of the oldest known metals, is so soft it can be pressed or hammered into very thin sheets or stretched without breaking.

1 Lead is very soft.



© Rich Treptow / Visuals Unlimited

Fish contaminated by lead pass the particles on to the people who eat them. Ecologists want stricter regulations about dumping chemical waste.

Because lead resists corrosion by water, acid, and chemicals, it's used in batteries and in paints for bridges and other steel structures. Solder, a lead-tin alloy, bonds metal parts in cars, pipes, and storage tanks. X-ray rooms are lined with lead because it shields against radiation. But despite its usefulness, lead can also be deadly.

Lead Problems

Lead interferes with the body's production of red blood cells and can damage the brain and other organs. Fumes from industrial plants often contain lead, and their chemical waste pollutes drinking water and harms or kills fish. We can inhale or swallow lead particles, or absorb them through the skin. Paint in older buildings often contains lead. Many young children are poisoned when they eat or inhale paint chips. Today paint used in homes is lead-free.

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Which is the person who makes furniture?

SCIENCE AND TECHNOLOGY

1. Architect
2. Bureaucrat
3. Joiner

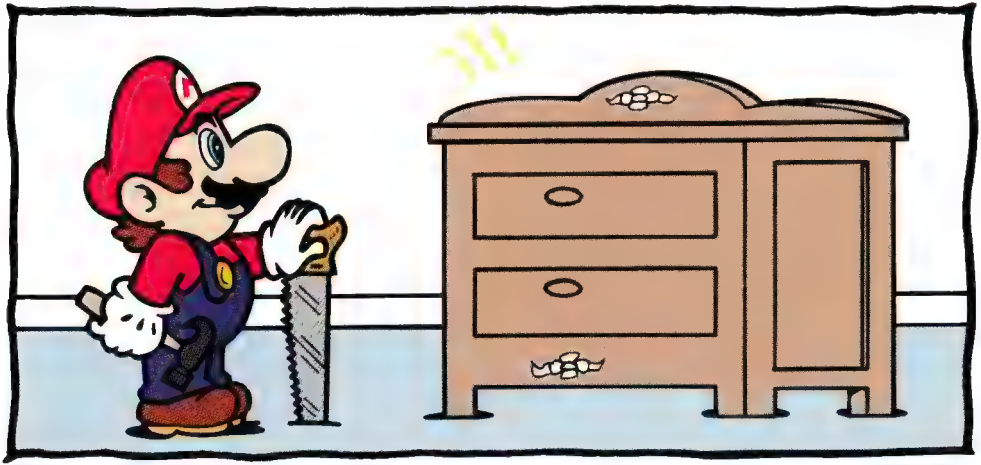

Illustration: Gary Fields

©1995 Nintendo

Joinery

Besides making furniture, joiners supply buildings with doors, window frames, shutters and floors.

A joiner is a craftsperson who builds furniture.

© Giraudon

The plane is one of the oldest woodworking tools used by joiners. It smoothes the surface of the wood.

Joinery is also known as finish carpentry because it puts the finishing touches on a room or building. Though both work with wood, a joiner and a carpenter perform different tasks. A carpenter does rough construction, such as the wooden framing for the structure of a house. A joiner is responsible for the decorative aspects of construction, like fancy moldings or millwork, banisters and doors.

A Traditional Art

Joinery got its name from the joints used to hold pieces of wood together. Centuries ago, before metal nails and screws were widely available, these finely crafted joints were vital to all types of wooden construction. Most were made by cutting a groove, or mortise, into one piece of wood and fashioning a projection, or tenon, on a second piece. The tenon fit into the mortise and held the pieces in place. Sometimes joints were secured with wooden pegs hammered into drilled holes, similar to the way we use wood screws today.

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Which of these is not a simple machine?

SCIENCE AND TECHNOLOGY

1. Lever
2. Inclined plane
3. Escalator

Illustration: Gary Fields

©1995 Nintendo

Levers

The lever, inclined plane, and wheel and axle are simple machines. The simplest of them all, the lever, helps us lift things by using balance.

3 An escalator is not a simple machine, it consists of complex machinery.

© C. E. Arnett / Visuals Unlimited

If the weight on each side of a seesaw is equal, the seesaw balances.

A good example of a lever is a seesaw—a board resting on a bar called a fulcrum. If you push down on one end of the seesaw, the person sitting on the other end is lifted. The farther your end is moved from the fulcrum, the less effort you need to lift the other person.

Classes of Levers

A balanced seesaw and a crowbar are examples of first-class levers—their fulcrums are between the weight (load) and the effort (push down or pull up). An effort of 6.6 pounds (3 kg) is needed to lift 6.6 pounds (3 kg). A wheelbarrow is a second-class lever; its load is between the fulcrum (axle through the wheel) and effort (pull-up handles). If you rest your elbow on a table and lift your forearm, you're using a third-class lever. The effort (pull up) is between the load (arm) and fulcrum (elbow joint).

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What makes crystal transparent?

SCIENCE AND TECHNOLOGY

1. Lead oxide added to the glass paste
2. Glass paste is cooled quickly
3. It is made with rock crystals

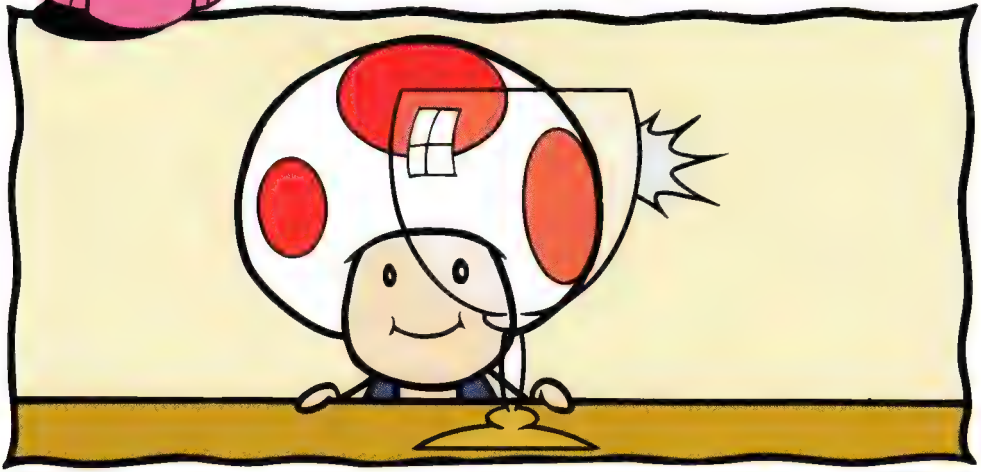

Illustration: Gary Fields

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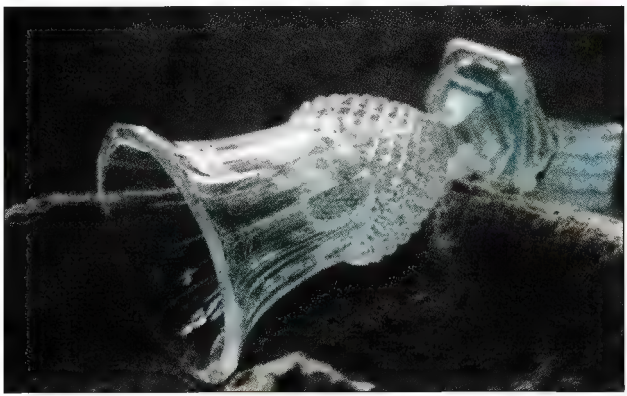
Lead crystal

Glassmakers in Italy developed a clear crystal glass in the 1500s.

1 **Crystal is transparent because lead oxide is added to the glass paste.**



© Sipa Press

Baccarat is a famous French crystal maker.

In 1673 an Englishman named George Ravescroft, found that by adding lead to the glass paste, he obtained a brilliant sparkling clear glass which was called lead crystal.

Lead crystal is softer than other types of glass. The softness makes crystal easier to cut than glass. By adding even more lead to the glass paste, English craftsmen succeeded in producing a heavier crystal glass. Elaborate geometric patterns could then be carved into the crystal. Some of the most famous crystal made today is made in Waterford, Ireland.

Pretty and Practical

Because lead glass bends light rays at different angles, it was used to make lenses for high-quality telescopes and microscopes as well as some of the world's most beautiful and expensive tableware.

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Since when have houses had glass windows?

SCIENCE AND TECHNOLOGY

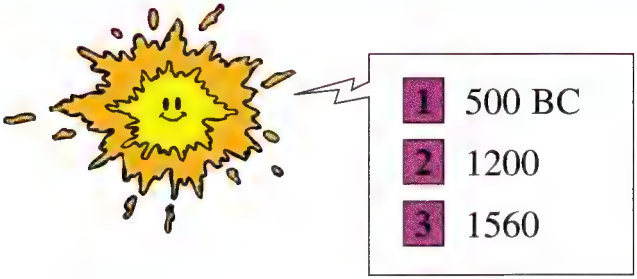

Illustration Gary Fields

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Windows

Ancient Egyptian wall drawings show openings in house walls covered with matting. In early Greek and Middle Eastern buildings, slabs of marble, sheets of mica, and oiled paper were used to cover window openings.

1 As far as historians can tell, glass windows have existed since the days of the Roman empire, about 500 B.C.

© Mark E. Gibson / Visuals Unlimited

Modern homeowners enjoy light and a view of the outdoors from their home's windows.

The first glass windows were made of small panes of glass, separated by metal bars, which were held together by bronze frames. During the Roman Empire the technique of glazing was developed. Glazed windows are held in place by some sort of putty. Glazing also improves insulation by making it harder for cold, wind, or rain to enter through the window. Roman glazed windows were mostly framed in bronze. The Byzantines (ancestors of the Turkish people) are also believed to have had glazed windows.

Stained-glass Windows

The colorful stained-glass windows we see in churches and cathedrals became popular when the Gothic style of architecture was introduced in the 12th century. These elaborate windows are made of small pieces of colored glass fused together with lead.

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When were tape recorders invented?

SCIENCE AND TECHNOLOGY

1. 1776
2. 1898
3. 1973

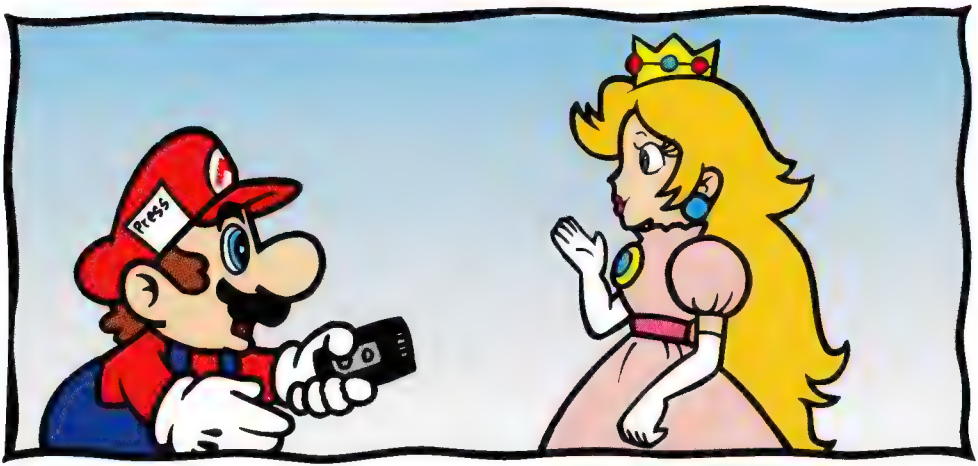

Illustration: Gary Fields

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The Tape Recorder

In 1898 Valdemar Paulsen from Denmark invented the telegraphone, the first machine that could record sound magnetically. It was a forerunner of today's tape recorders.

2 The first tape recorder was invented in 1898.

© Glories / Stpa Press

Above is an early version of the magnetic tape recorder.

In 1940 a German firm perfected a recording device they named the magnetophon. It was the first recorder to use plastic tape.

Recording at home

Home recorders became widely available in the mid-1950s. Reel-to-reel models required the user to thread the tape from one spool to another. In the process, tape often twisted or broke. In the 1960s, cassette tapes were introduced, making it much easier for home users to handle their tapes. The tape inside a cassette is coated with a type of magnetizable powder. As it rolls past the tape recorder's electromagnetic recording head, sound impulses are recorded, or "printed" on the tape. The machine's playback head translates this "print" back into the sounds of music or voices we hear through the audio speakers.

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What is cast iron?

SCIENCE AND TECHNOLOGY

1. A surgeon's instrument
2. Melted iron poured into a mold
3. A theater prop

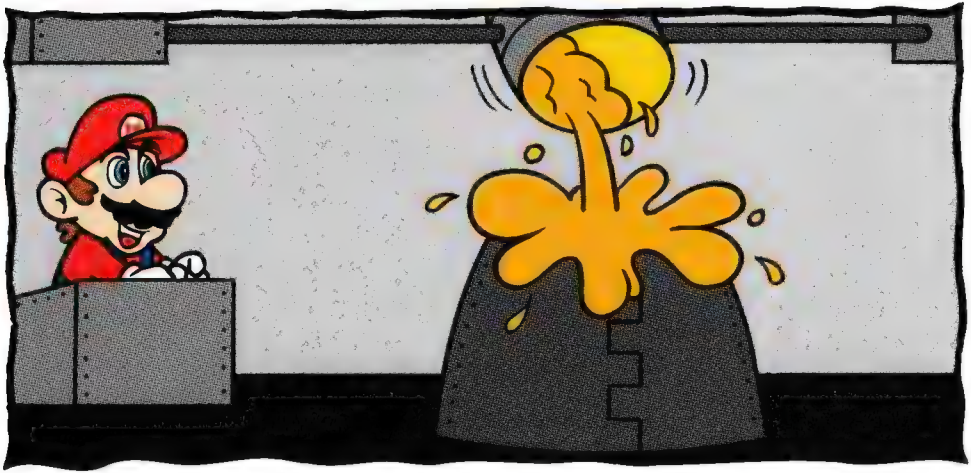

Illustration: Gary Fields

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Iron

Iron is one of the oldest metals known to man. Prehistoric man made tools, weapons, and eating utensils of iron.

Iron ore makes up about five percent of the earth's crust. It is usually found combined with elements such as oxygen, carbon, sulfur, and silicon. The most common iron ores are magnetite, hematite, limonite, siderite, and taconite. In order to extract the iron, the ore is placed in an extremely hot furnace. Here the iron melts and can be separated from the impurities.

Melted iron poured into a mold is called cast iron. Once it has cooled and become hard, it is known as pig iron. This name was given by iron workers who noticed a resemblance between the small sand molds surrounding the blast furnace and suckling pigs around their mother.

Making steel

Today most of the iron mined is used to make steel. Steel is an alloy or combination, of iron ore and carbon. It is shaped more easily than iron and manufactured inexpensively.

2 Cast iron is melted iron poured into a mold.

© Aral / Sipa Press

Iron ore melts at 2,795°F (1535°C).

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How long has the metric system officially been in effect?

SCIENCE AND TECHNOLOGY

1. 5 years
2. 196 years
3. 3,000 years

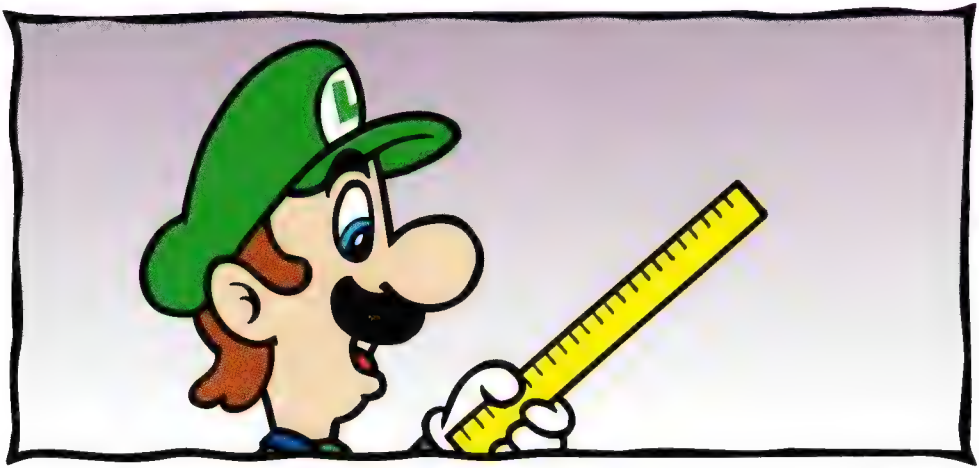

Illustration: Gary Fields

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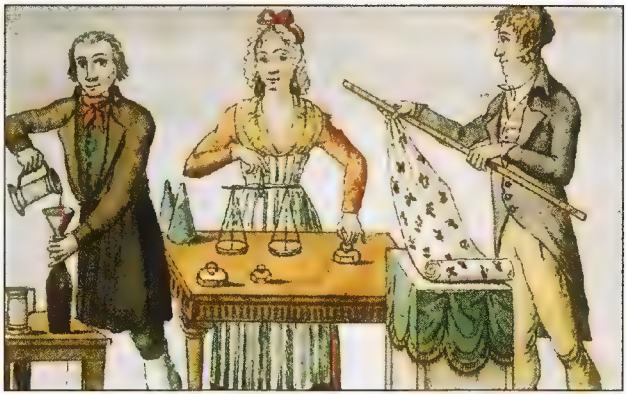
Metric System

Until the 17th century every country had its own system of measurement. This made commercial trade between among countries very confusing.

2 The metric system has officially been in effect for 196 years.



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The metric system took a long time to be adopted.

The idea of the metric system existed as early as 1670, but was not fully developed until the 1790s. At that time the leaders of the French Revolution instructed the French Academy of Sciences to devise a simple, logical, united system of weights and measures. These standards of measurement, officially adopted in 1840, made international trading easier.

Metric Measures

The metric system is based on multiples of ten. The system is divided into two parts. One part is the meter, used to measure length; and the second part is the kilogram, to measure weight. One meter equals 3.3 feet, and a kilometer (or 1,000 meters) equals 1.2 miles. One kilo equals 2.2 pounds and a metric ton equals 2,200 pounds.

Today the metric system is followed in most countries around the world, but it is not officially accepted in the United States.

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How much weight can a crane lift?

SCIENCE AND TECHNOLOGY

1. 500 lbs (227 kg)
2. 1,500 lbs (682 kg)
3. 3,000 tons (272,727 kg)

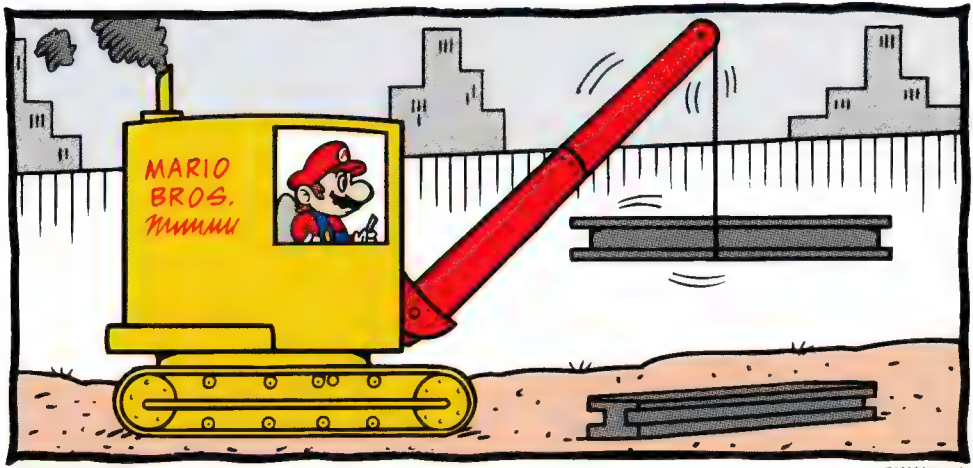

Illustration Gary Fields

©1995 Nintendo

Crane

A crane is a machine that lifts objects and moves them horizontally. Cranes usually grasp a load with a hook. A system of pulleys and cable, called block and tackle, lifts the load. The long arm which moves the load is the boom.

A crane can lift up to 3,000 tons (272,727 kg).

© Len Sirman

Cranes are familiar sights at today's city building sites.

One type of crane is called a derrick. Early derricks were made with a leaning, but almost vertical, pole that had hoisting tackle supported from the top. The load was hoisted by ropes connected over a pulley at the top of the pole to a winding device on the ground. The load was moved sideways with a swinging motion. The top of the pole was braced by lines tied to the ground away from the pole. Today's derricks and cranes are made of steel and use wire ropes. The majority of them are also driven by internal-combustion engines or electric motors which provide power to lift and shift a load.

Mighty Fork Lifts

Among the most popular types of cranes are the fork-lift trucks. These are found in almost every warehouse and loading dock. They lift anything from drums to crates.

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What is marble?

SCIENCE AND TECHNOLOGY

1. A precious gem
2. A bird's mating call
3. Hard decorative stone

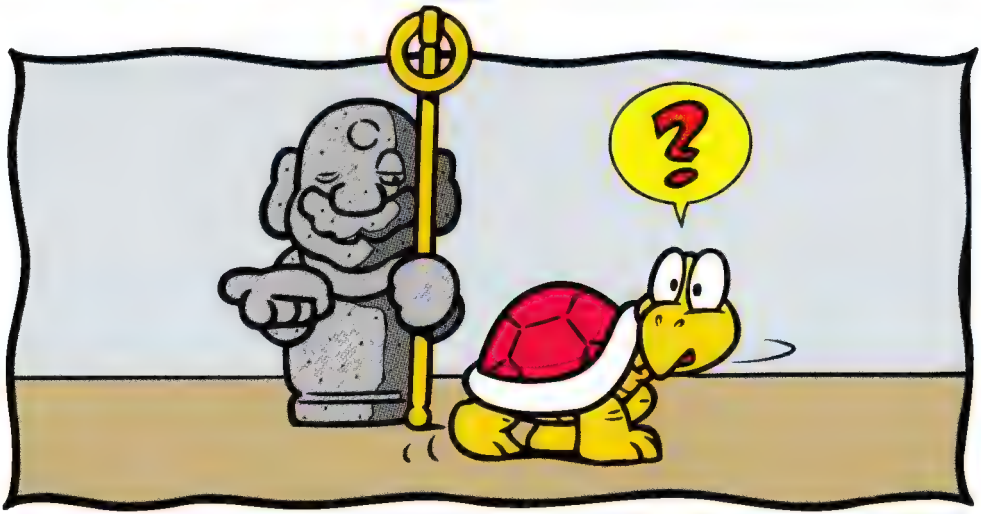

Illustration: Gary Fields

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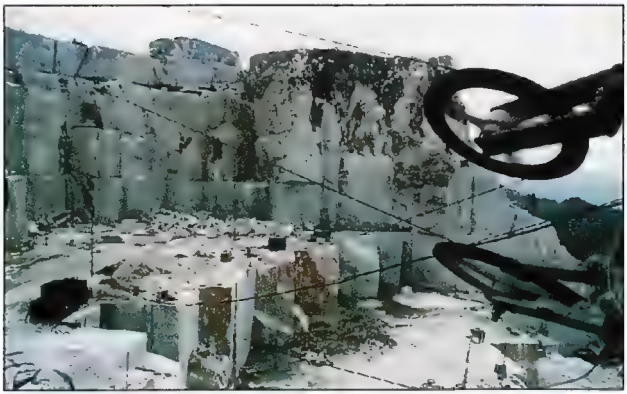
Marble

Marble is calcium carbonate, the mineral remains from the skeletons of tiny sea animals called crustaceans which have been pressed into limestone and hardened by pressure, heat, and water.

3 Marble is a hard decorative stone.



© Len Sirman

Marble can be quarried as slabs for building or as crushed or broken stone used in some types of floors and in pavement for roads.

Pure marble is white. Impurities are what give marble its wide variation in color, as well as its rich veining and clouding. These color variations give the stone a sort of personality. That's one reason marble has been a favorite medium for sculptors for thousands of years.

Marble's Many Uses

Because marble is waterproof, fire-resistant, easy to cut and carve, and attractive, it has long been a favorite of builders and architects. Some marble structures built thousands of years ago are still standing today.

Although many beautiful varieties of marble come from Western Europe and North Africa, over 120 types of marble are found in the United States. Most are quarried on the East Coast, Colorado, and Arkansas. The Lincoln Memorial in Washington D.C. is made entirely from marble quarried in the United States.

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Which substance is used to make plastic?

SCIENCE AND TECHNOLOGY

1. Petroleum
2. Clay
3. Sand

Illustration, Gary Fields

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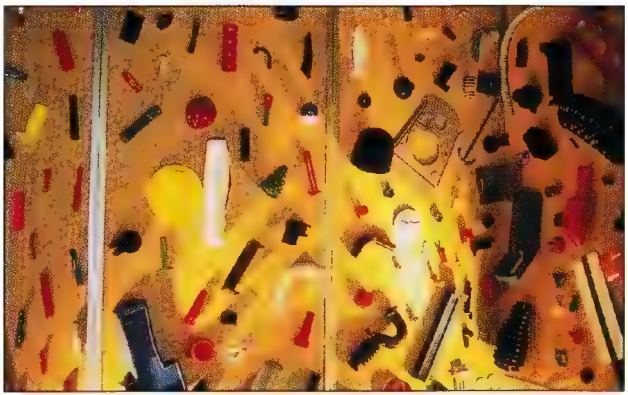
Plastic

Plastic is not a modern creation. Hundreds of years ago plastic materials were made from certain tree saps called gutta percha, tiny insect secretions called shellac, and animal horns.

1 **Petroleum is used to make plastic.**



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Plastic comes in all shapes, sizes, colors, and pliability.

Plastic softens when heated, so it can be easily shaped and molded. When cool, it becomes rigid and hard. This is because plastic is made up of big molecules called polymers which expand when heated, making plastic pliable, and come together tightly when cooled, making the plastic hard.Celluloid was the first modern form of plastic. It is best known for its use in photographic film. Casein plastics, made by mixing a milk protein called casein with formaldehyde, were developed around 1900. Some are used today to make buttons.

Perfect Substitute

As production technology improved, plastic became a low-cost, lightweight substitute for other materials. Items such as hairbrushes and combs, which once were made of ivory or wood, could be produced faster and cheaper using plastic. Toys, once made of metal, were recast in plastic.

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What was the first plastic to be manufactured industrially?

SCIENCE AND TECHNOLOGY

1. Celluloid
2. Silly Putty
3. Polyester

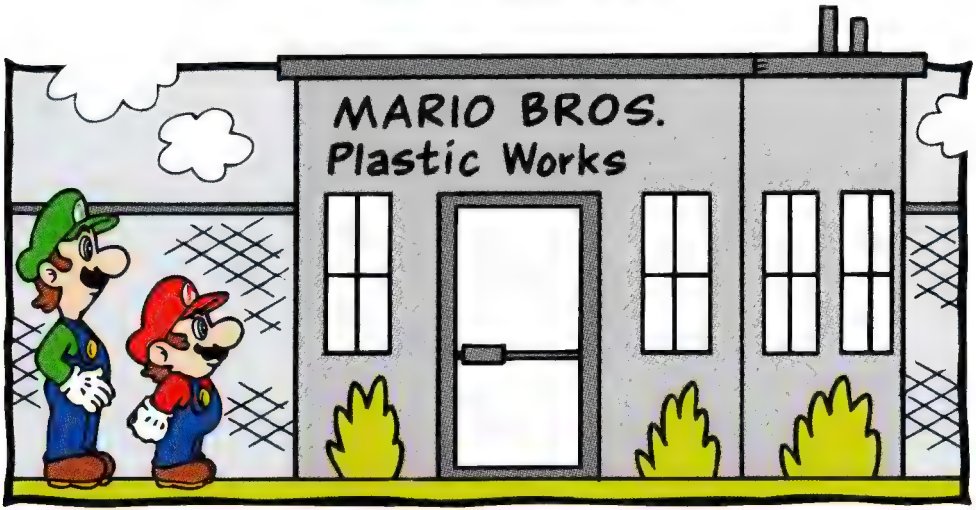

Illustration Gary Fields

©1995 Nintendo

Celluloid

In 1869, a New Jersey inventor named John Wesley Hyatt, discovered celluloid—the first partially synthetic plastic—while trying to find a material, other than ivory, with which to make billiard balls.

1 Celluloid was the first plastic to be manufactured.

© Nahoussia / Sipa Press

Strips of celluloid coated with a light-sensitive film were used in photography and movie making.

Hyatt found that by mixing and heating nitrocellulose, camphor, and alcohol, he obtained a pliable substance which hardened into a tough, strong plastic.

For the next thirty or so years, celluloid was practically the only plastic produced commercially, and it was used to make mass-produced consumer goods. In 1889, George Eastman began marketing cameras with celluloid film. With the start of the movie industry, the celluloid industry boomed.

A Flammable Material

Because celluloid was found to be flammable, it was later replaced in certain applications by synthetic polymers. The discovery of phenol-formaldehyde resin in 1909 almost completely ended the use of celluloid. But celluloid is still used for specific applications, such as combs, brushes and buttons.

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What is a seine?

SCIENCE AND TECHNOLOGY

1. A type of castle
2. A fishing net
3. A mammal

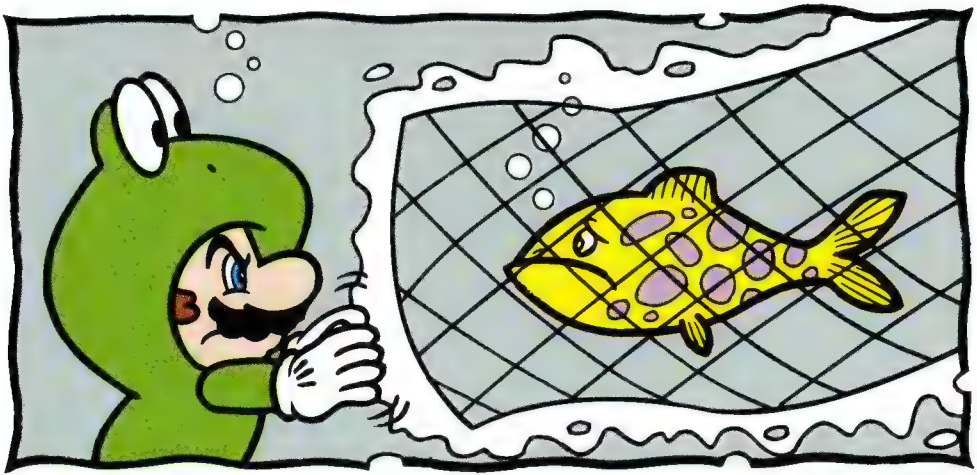

Illustration Gary Fields

©1995 Nintendo

Seine Nets

Seine nets are also called round or ring nets. They are vertical commercial fishing nets used to encircle schools of fish close to the water's surface.

A seine is a fishing net.

© Len Sirman

Over one-third of all the fish caught in the world are caught with seine nets.

A seine is one of the three most common commercial fishing nets. It is used for freshwater as well as saltwater fishing. In lakes, the seine is rolled out in autumn or winter when the fish collect in the deeper parts of the lake. The seine net has wings—some are up to 3,300 feet (1,000 m) long—and towing lines. The lines are used to drag the net along the lake bottom as it surrounds the fish. Motorized towing, as opposed to men pulling the nets in, has made harvesting catches easier.

Saltwater Fishing

The purse seine net is the most frequently used net for saltwater fishing. It is responsible for capturing more fish every year than any other net. Surface fish are encircled from the side as well as from the bottom making it impossible for them to escape. With purse seines commercial fisherman catch herring, cod, mackerel, and tuna.

The other two widely used nets are trawls and gill nets.

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What is framing in construction?

SCIENCE AND TECHNOLOGY

1. A factor of interior decorating
2. A skeletal structure designed to support or enclose something
3. Building a cement foundation

Illustration: Gary Fields

©1995 Nintendo

Framing

Today, wood is used to build the skeletal structure, or frame, of most homes. A well-built wood-frame home is very durable.

2 Framing is a skeletal structure designed to support or enclose something.

© Len Sirman

In some countries, it is customary to hang a bouquet or a small tree on the ridge beam to celebrate the completion of the framing.

Buildings framed with lumber fall into two main categories: conventional framing, and plank-and-beam framing. The latter consists of heavier beams spaced more widely apart.

Conventional Framing

The type of conventional framing most widely used in North America is called platform framing, and is primarily used for one-story dwellings. In this type of construction, the floors are platforms separate from the walls. They provide a platform upon which exterior walls and interior partitions are erected.

Platform construction is easy to erect because at each floor level it provides a flat surface on which to work. In fact, the framing for a whole wall is often assembled on the floor, then lifted as one piece and nailed into place. Once the frame is complete, the walls are covered, or sheathed, with sheets of wood or other material.

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What is off-shore drilling?

SCIENCE AND TECHNOLOGY

1. A method of reaching oil beneath bodies of water
2. A treatment for cavities
3. A form of boat construction

Illustration: Gary Fields

©1996 Nintendo

Petroleum

Petroleum, or crude oil, is a natural substance found below Earth's surface. It is used as fuel and as a raw material in the manufacture of medicines, fertilizers, plastics, building materials, and paints.

1 **Off-shore drilling is a method of reaching oil beneath bodies of water.**

© D. Allen / Hoaqui

Drilling rigs like this one are installed, operated, and serviced on platforms in water up to several hundred yards deep.

Petroleum geologists and geophysicists locate reservoirs of petroleum by examining the Earth's surface for clues about what lies underground and analyzing samples of Earth's crust. To reach the oil, a well is drilled.

Drilling a Well

The rotary method has been used to drill most oil wells in the United States. In this type of drilling, a drill string—a series of connected pipes—is supported by a tall frame called a derrick. At the end of the string is a drill bit that cuts through Earth as the string is rotated. As the drill string penetrates Earth's crust, more lengths of drill pipe are added. Drilling into an oil reservoir releases underground pressure and causes the oil to flow toward the surface where it can be collected.

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Where is oil found?

SCIENCE AND TECHNOLOGY

1. In forests near large lakes
2. In caves
3. In layers of sedimentary rock

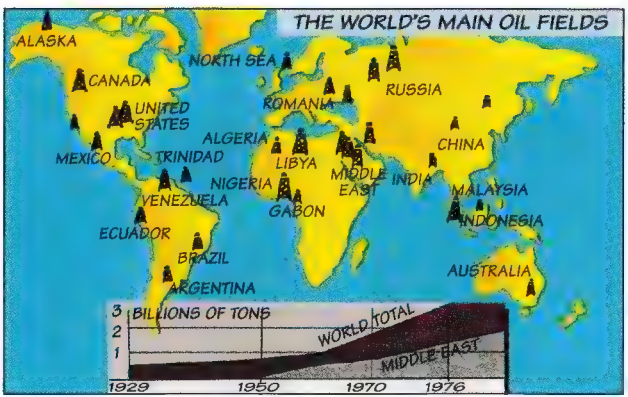
Illustration, Gary Fields

©1996 Nintendo

Crude Oil

Crude oil, also called petroleum, is a natural liquid substance found underground.

3 Oil is found in layers of sedimentary rock.



Locations of the world's main oil fields.

Crude oil may be as thin as gasoline or so thick that it will barely pour. It is formed by the decomposition of marine organisms. When marine animals and plants die, they sink to the ocean floor and form layers of sediment mixed with fine sand and silt. Over millions of years, these layers of loose sediment harden. Newer layers of sediment put pressure on older, deeper layers and cause a rise in temperature of several hundred degrees. With the weight of more recent deposits and the passage of millions of years these layers of sediment turn to stone and petroleum.

Coming to the surface

Petroleum below the surface of the Earth is forced upward because it is less dense than the other fluids found in the Earth's crust. When petroleum meets a layer of impermeable rock that it cannot flow through, it stays underground and collects in a pool, or reservoir.

Geologists and geophysicists analyze soil samples and examine the Earth's natural landscape to determine the location of potential oil deposits for mining.

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What is OPEC?

SCIENCE AND TECHNOLOGY

1. A political party
2. An organization concerned with crude-oil policies
3. A form of rapid transit

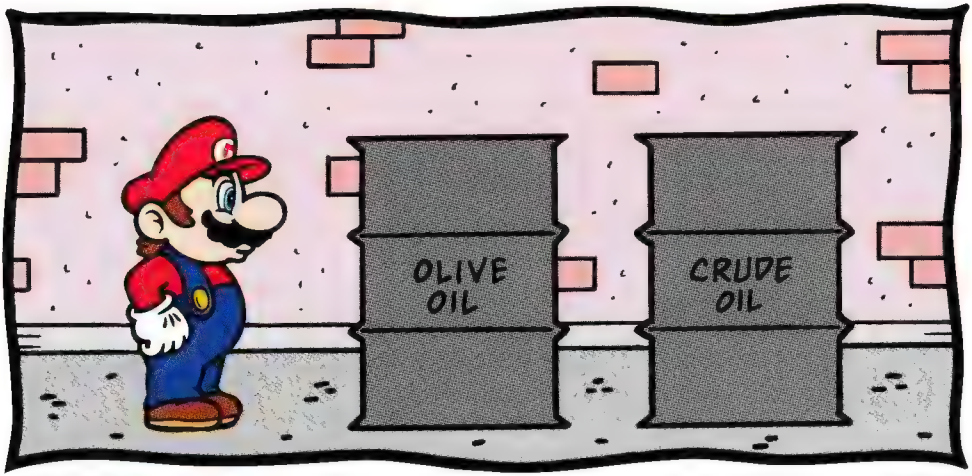

Illustration: Gary Fields

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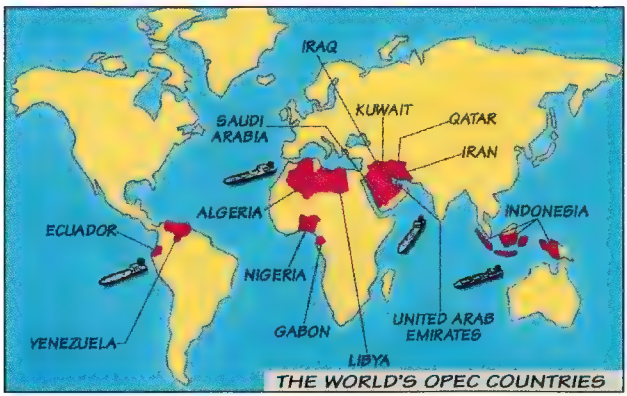
OPEC

The Organization of Petroleum Exporting Countries (OPEC) is an international organization that was founded in 1960.

2 OPEC is an organization concerned with crude-oil policies.



© Y. Tabariès

Beginning in the 1970s, OPEC countries worked to increase the price per barrel of oil.

Because in the late 1950s, more oil was produced worldwide than was needed, oil companies lowered prices and paid oil-producing nations less money for their oil.

OPEC was formed in response to the price cuts made by American and European oil companies. Initially, OPEC focused on keeping oil prices from dropping. Then, in 1970, it began to push for increases. Prices remained about the same from 1974 to 1978, but they increased by more than 100 percent during 1979. Demand for oil went down as prices rose, and non-OPEC oil producers increased their production of oil.

Political Power

OPEC has used the supply of oil as a political tool. For example, it refused to supply oil to countries that supported Israel in the Arab-Israeli War of 1973. This caused oil and gasoline shortages in many countries. Recently, however, disagreements among member countries have caused OPEC to lose much of its influence.

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What is the speed of light?

SCIENCE AND TECHNOLOGY

1. 186,000 miles (300,000 km) per hour
2. 186,000 miles (300,000 km) per minute
3. 186,000 miles (300,000 km) per second

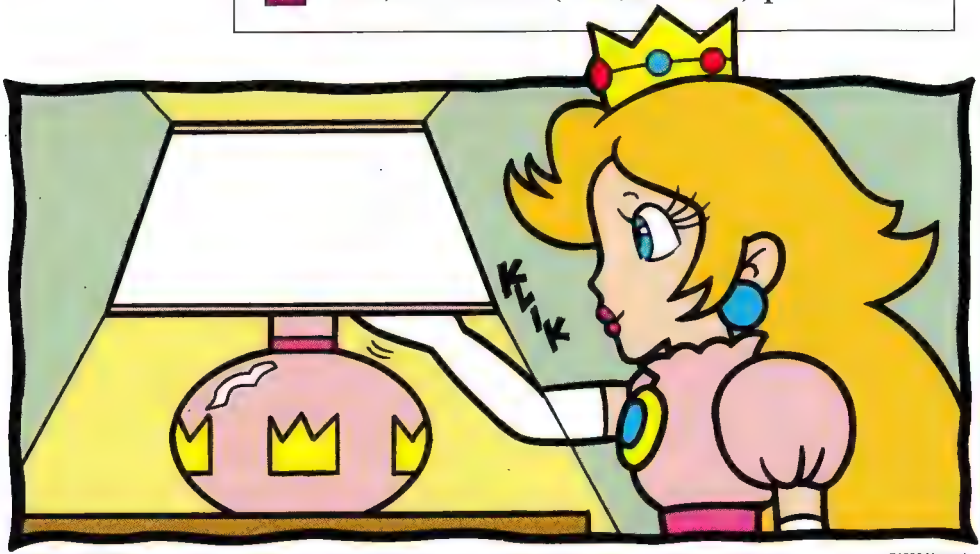

Illustration Gary Fields

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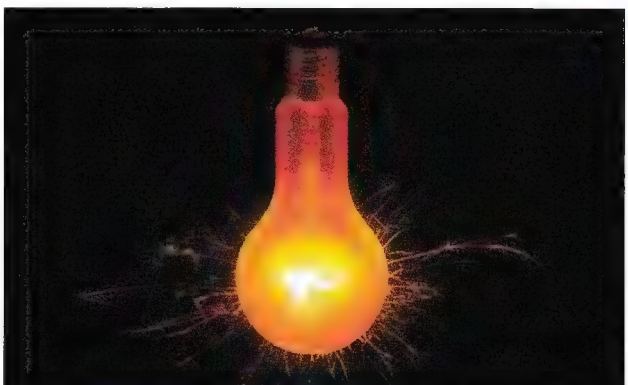
Light

Light is a flow of charged particles in perpetual straight-ahead motion. When light hits air, water, glass, or any matter, it slows down slightly and its rays bend.

3 Light travels at a rate of 186,000 miles (300,000 km) per second.



© Len Sirman

When you turn on a switch, light instantly fills the room. Well, almost instantly. The time it takes light to cover the distance between the light bulb and our eyes is a fraction of a second.

In a vacuum—the absence of air—light travels at exactly 1,859,871.40 miles (2,999,792.58 km) per hour. The speed of light in water is equal to three-fourths that of its speed in a vacuum.

A great deal of the universe is a vacuum, which means that light travels faster in outer space than it does within Earth's atmosphere. For instance, light travels from Sun to Earth in only 11 minutes. Still, other stars are so far away that their light takes millions of years to reach our eyes. So the stars we see in the sky tonight may no longer be in that position or even exist at all.

Composition of light

Light is made up of electromagnetic waves, which consist of electric and magnetic fields that vibrate at the same frequency.

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What is speed?

SCIENCE AND TECHNOLOGY

1. The direction in which an object moves
2. The distance an object moves during a unit of time
3. The force of gravity on an object

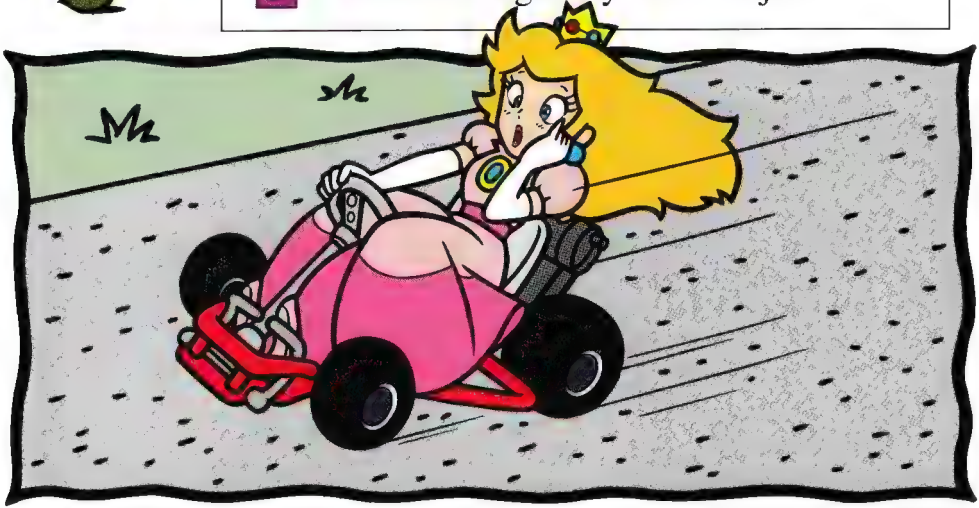

Illustration Gary Fields

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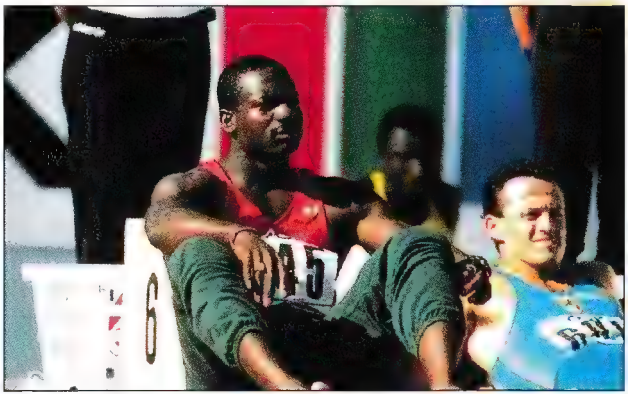
Speed

Speed refers only to the rate of motion of an object, while velocity refers to the rate and direction of motion.

2 Speed is the distance an object moves during a unit of time.



© Color Sport / Sipa Press

Every year, athletes compete to set new records for speed. The runner Ben Johnson ran 100 m in 9.83 seconds.

Certain speeds are imposed on us by nature and the laws of physics—the study of motion. For instance, Earth revolves around the sun at about 18.6 miles (30 km) per second, which determines the length of our year; and Earth rotates on its axis 360 degrees about every 24 hours (23 hrs. 56 min. 4 sec.), which determines the length of a day.

Measuring Speed

Speed is measured by mechanical means. Stopwatches, speedometers, and radar are all methods of measuring speed. Speedometers in cars use gears attached to the axles by wires. Each axle is connected to two tires. These gears measure the number of times an axle rotates every second. The number is converted to miles or kilometers per hour which is displayed for the driver.

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What metal is used to produce nuclear energy?

SCIENCE AND TECHNOLOGY

1. Gold
2. Uranium
3. Kryptonite

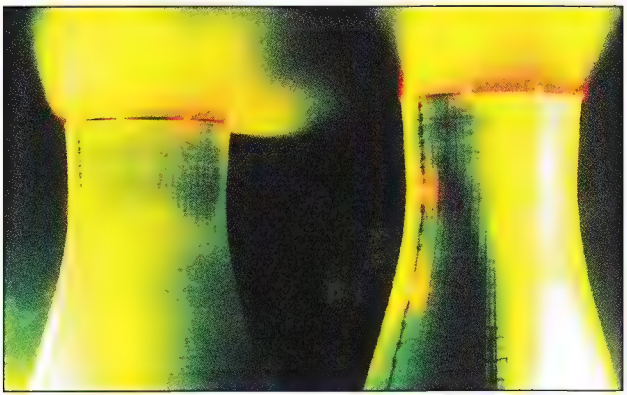
Illustration: Gary Fields

©1996 Nintendo

Uranium

Uranium is radioactive. Known for its role in nuclear fission—the atomic bomb—and its use in nuclear reactors to make energy, it can also be used in determining the age of rocks, and even of Earth.

2 Uranium is a metal used to produce energy.



© Len Sirman

Uranium is used in nuclear reactors to create the energy used by electrical generators. Reactors are encased in thick cement to prevent radiation from escaping.

You probably know that the gas used to run your car is a fossil fuel—it comes from animal and plant fossils found in Earth's crust. Uranium is also found in Earth's crust, but it is a metallic element. Its energy is not just used in nuclear reactors, but in bombs and even in submarines.

Energy Source

Uranium is radioactive—it constantly emits particles and rays. Radiation is actually a form of energy. Although some forms of radiation can be put to good use—X-rays are a high-frequency form of radiation—large doses of radiation can make us sick, and radioactive waste can be quite difficult to dispose of safely. Uranium was named after the planet Uranus. What other substances can you think of that might have been named after planets?

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What are statistics?

SCIENCE AND TECHNOLOGY

1. A body of official governmental predictions
2. The science of gathering and analyzing data in order to draw conclusions
3. The study of population growth

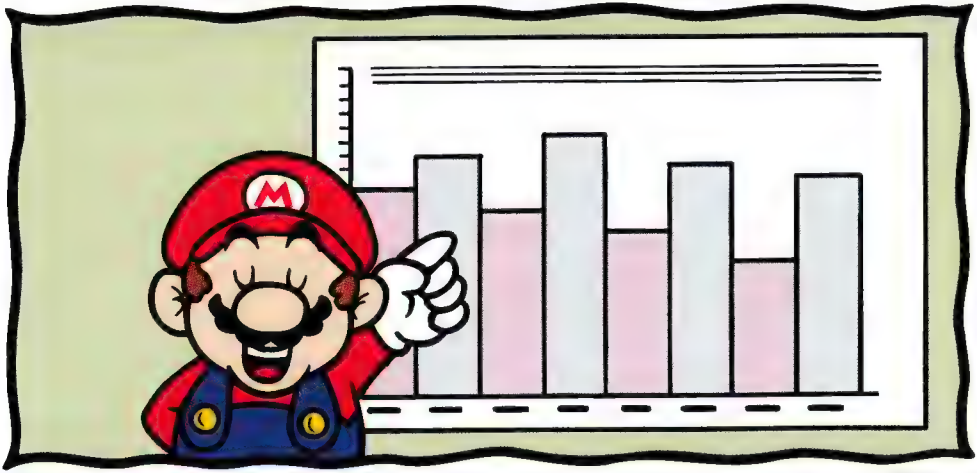

Illustration Gary Fields

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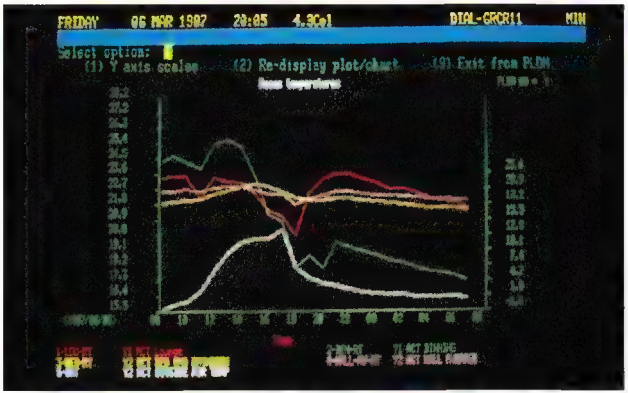
Statistics

Statistics, the science of analyzing numerical information, is used to make comparisons and predictions, establish probability, and make decisions.

2 Statistics is the science of gathering and analyzing data in order to draw conclusions.



© Senepart / Sipa Press

The curves or graphs used by statisticians enable them to better determine different tendencies and trends in what they are evaluating.

Did you ever wonder how many people shop at your local supermarket on an average day? How many kids in your class are likely to catch the measles this year? By collecting and analyzing numerical data, statisticians—people who study statistics—attempt to predict the likelihood of future events.

One Example

To predict the number of kids in your class who are likely to catch the measles, a statistician might consider a number of factors. He or she would need to know how many kids there are in your class, their ages, how many have been immunized against measles, and how many have already had the measles (since you rarely contract measles more than once). The statistician would also look at data from past years, to learn how many kids your age contracted measles in previous years. Using all these statistics, a statistician can make an educated guess about what is likely to happen in the future.

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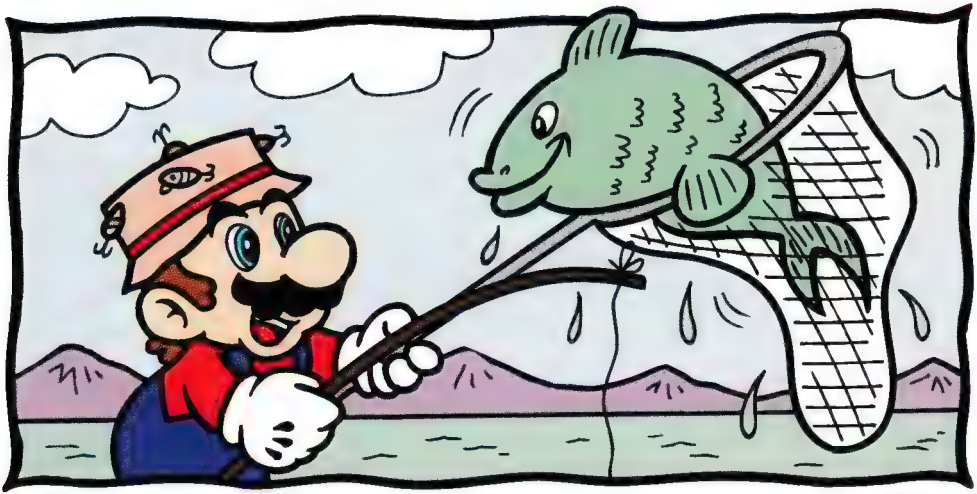
What are modern fishing nets made of?

SCIENCE AND TECHNOLOGY

1. Rayon
2. Twine
3. Nylon



Illustration, Gary Fields

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Fishing Nets

Modern fishing nets are primarily machine-made from sturdy nylon. They may be fine or heavy, mobile or stationary, depending on their function.

Modern fishing nets are made of nylon.

© Len Sirman

Nylon is also used to make parachutes.

Nets have been used since Paleolithic times—as far back as 2,000,000 B.C. Their ropes and cords were made from animal or vegetable tissue like bark, leaves, hide or hair. Modern nets are usually made from vegetable fibers such as cotton or hemp or from man-made fibers like nylon and polyester—and they are made by machines. These man-made fibers do not rot. In fact, they are quite durable.

Sturdy Nylon

Nylon was the first synthetic fiber invented, and it is actually a type of plastic. Today, most fishing nets are made of nylon. These nets come in many different shapes and sizes, and each has a specific function. Corks, weights, and floats may be attached to them to help position them properly. Nets function in many different ways. Some entangle the fish, some trap the fish in pockets, some just gather fish up, and some are structured so that fish can enter them but cannot exit them.

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What is wind energy used for?

SCIENCE AND TECHNOLOGY

1. To mill grain, pump water, and generate electricity
2. To create air conditioning
3. To make windmills

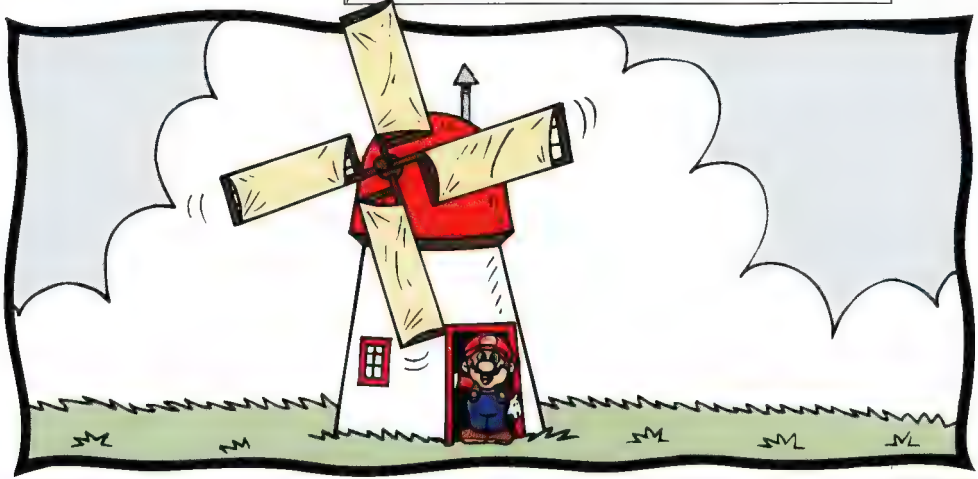

Illustration: Gary Fields

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Windmills

Wind-driven mills are of ancient origin. They were used in Persia as early as the 7th century A.D. to mill grain and irrigate fields.

1 Wind energy is used for such things as milling grain, pumping water, and generating electricity.

© Len Sirman

The best places for windmills are coastal regions and great plains, where the winds blow constantly.

Modern wind turbines are propelled by one of two methods: The drag method, in which wind pushes the blades of the windmill; and the lift method, in which the blades rise on air currents like the wings of an airplane. Turbines operated by lift turn more rapidly and efficiently than those using the drag method.

Wind Speed

Generally, machines start working when wind speeds reach 12 miles per hour (19.2 km/h), achieve their best rates at 25-30 miles per hour (40-48 km/h), and shut down in wind speeds of 60 miles per hour (96 km/h). The best sites for turbine generators have annual average wind speeds of at least 13 miles per hour (20.8 km/h). The largest wind farms are in California, where wind turbines can generate power up to about 1120 megawatts. Scientists have estimated that as much as 10 percent of the world's electricity could be provided by wind generators by the middle of the 21st century.

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What is a fire hydrant?

SCIENCE AND TECHNOLOGY

1. An underground water tank
2. A kind of faucet that draws water from underground water mains
3. A device used to start fires

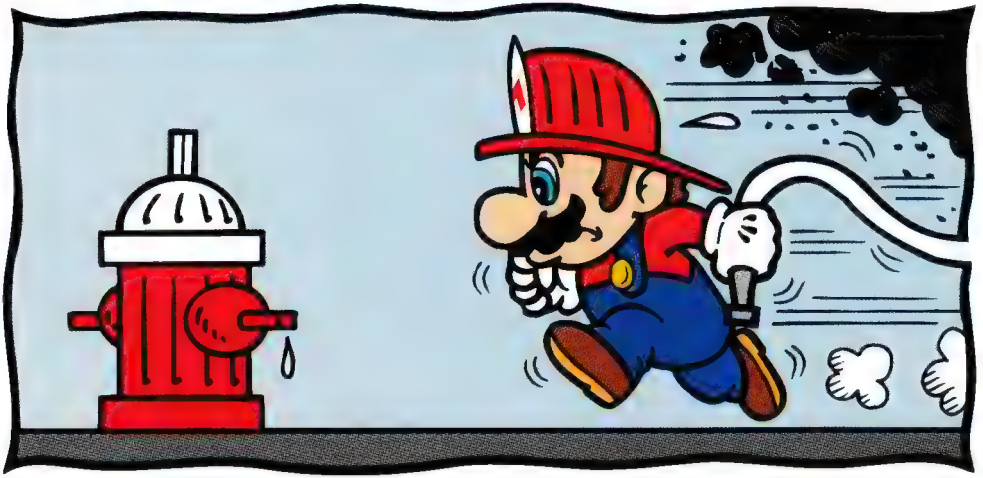

Illustration: Gary Fields

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Hydrant

Hydrant comes from hydro—Greek for water. Hydrants are actually upright pipes with nozzles. Firefighters depend on them to fight fires.

2 A fire hydrant is a kind of faucet which draws water straight up from underground water mains or pipes.

© Beutter / Gamma

Fire hydrants make it possible for firefighters to have access to a large supply of water.

The first modern fire engine was invented in 1721. Its pump produced a jet of water strong enough to break glass. But imagine how hard it would be to fight a big fire if all of the water had to be carried to the scene in trucks. That is why pumps and hydrants are so useful and appreciated.

How it Works

Like the faucets in your house, fire hydrants depend on water pressure in order to produce enough water and force to put out blazing fires. Fire hydrants quickly draw water straight up from underground water mains creating the great water pressure or force needed to operate fire hoses. Once a fire hose is connected to a fire hydrant, the force of water coming from the hose is strong enough to put out huge flames.

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What was the name of the first computer?

SCIENCE AND TECHNOLOGY

1. ENIAC
2. LASER
3. RADAR

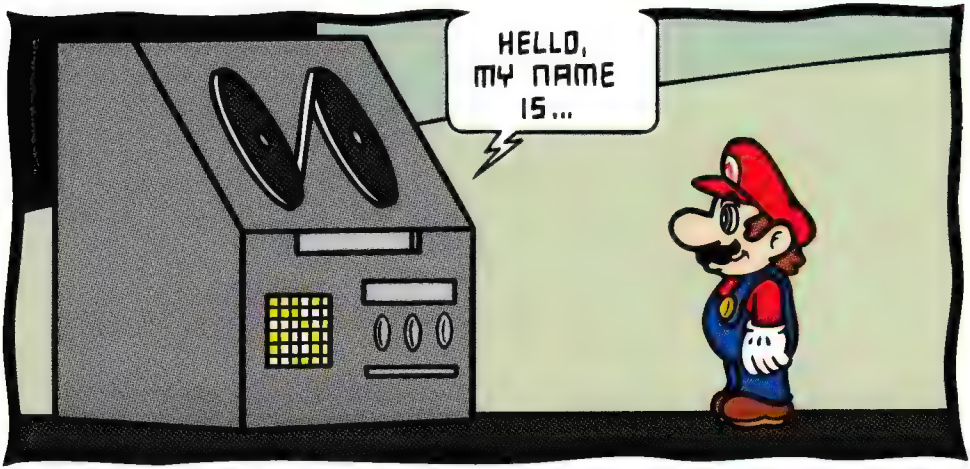

Illustration Gary Fields

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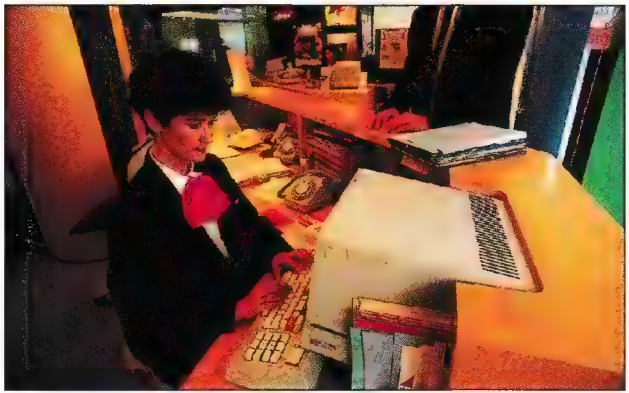
ENIAC

The Electronic Numerical Integrator and Computer, or ENIAC, was developed in 1946.

1 The first computer was called ENIAC.



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The development of computers was a major advance in the world of high technology. Computers are used to handle and communicate information in many different fields.

Many historians consider British mathematicians Charles Babbage and Augusta Ada Byron the true inventors of the digital computer. One of their inventions, the Analytical Engine, had much in common with modern computers. Howard Aiken, an American mathematician, created the first digital computer. Aiken's machine had no internal memory, but in 1945 Hungarian-American mathematician John von Neumann built a computer with program storage.

Birth of ENIAC

ENIAC, the first entirely electronic computer, was built in 1946 by Americans John Presper Eckert, Jr. and John William Mauchly. After transistors were developed in the late 1950s, smaller, faster computers could be built. In the late 1960s, engineers developed a way to put many wire-joined transistors onto a single plate. This made it possible to build microprocessors equipped with large scale and then very large scale integrated circuits.

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Who invented the first vacuum cleaner?

SCIENCE AND TECHNOLOGY

1. Eli Whitney
2. Juliet Howe
3. James Murray Spangler

Illustration: Gary Fields

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James Murray Spangler

James Murray Spangler sold the rights to his invention to William Henry Hoover. Hoover was the first manufacturer to successfully mass-produce and market vacuum cleaners.

James Murray Spangler developed one of the first portable electric vacuum cleaners.

© Belly / Diaf

Today vacuum cleaners come in many different sizes: There are hand-held models for cleaning tabletops and car interiors, and upright models for cleaning larger surfaces, such as floors.

Vacuum cleaners work with suction, much like straws. As you suck air into a straw, you are lowering the air pressure inside the straw relative to the surrounding air. This pushes down on your drink and causes it to be forced up into your mouth.

In a cylinder vacuum cleaner, suction is created when an electric motor runs a fan that pumps all the air out of the vacuum cleaner's hose. Atmospheric pressure forces air up into the vacuum cleaner, and this air pulls dust and dirt with it.

Accessories

Some vacuum cleaners have a rotating brush that beats dust and dirt out of rugs before it is sucked into the vacuum cleaner bag. Many cleaners are equipped with a set of brush attachments designed to clean different types of surfaces.

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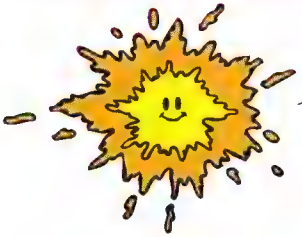
How does a remote control unit work?

SCIENCE AND TECHNOLOGY



1. Infrared light beams
2. Radar signals
3. Sonar

Illustration: Gary Fields

©1996 Nintendo

Remote Control

California-born engineer John Hays Hammond, Jr., had developed radio remote control by the beginning of World War I, in 1914.

1 **Remote control units work by sending invisible infrared light rays to a receiver.**

© Michael A. Keller / Third Coast Stock Source

Today, remote control units are used for television sets, VCRs, garage door openers, radios, and CD players.

Hammond invented a radio-controlled torpedo and perfected techniques to stop enemies from interfering with remote control signals. His discoveries are the foundation of modern missile guidance systems.

A Household Device

Today, remote control devices are found in most households. A remote control unit works by sending an invisible beam of infrared rays to a receiver inside an electronic appliance, like a CD player or television set. This beam contains a signal composed of electrical pulses. The receiver picks up and decodes the pulses, which tell the TV to change the channel or the VCR to rewind a cassette, for example. Both transmitters and receivers contain devices called diodes that allow electric current to flow in one direction but not the other. Receivers contain photodiodes which sense infrared light rays and decode the signals sent by the transmitter.

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What is used to pave roads?

SCIENCE AND TECHNOLOGY

1. Asphalt
2. Marble
3. Lucite

Illustration: Gary Fields

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Paved Roads

Asphalt, tar, and cement are mixed with coarse or fine sand or gravel to make the material used in paving roads.

1 Asphalt is a main ingredient in the material used to pave roads.

© Lirmer / Jernean

Asphalt and tar are very elastic, or flexible. Surfaces paved with asphalt and tar expand in hot weather and contract in the cold without extensive cracking.

The amount and nature of each ingredient used in making pavement determines how rigid or flexible the road surface will be. Flexible pavements are made from a mixture of coarse or fine aggregate (ground stone, gravel, and sand), tar, and asphalt. Flexible pavements can withstand considerable shock and heavy traffic. Rigid pavements are made from a blend of cement and coarse and fine aggregate. A layer of sand or fine gravel is often spread below pavement to provide support. In addition, paved roads may be reinforced with steel to prevent cracking. Pavement thickness varies from 6 to 18 inches (15 to 45 cm), depending on traffic density.

Finishing Touches

After pavement is laid, many roads are painted with markers to separate lanes of traffic, warn drivers of a reduction in speed limit, and indicate parking spaces.

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What are petrochemicals?

SCIENCE AND TECHNOLOGY

1. Rare minerals extracted from cave walls
2. Solids produced by combining two acids
3. Substances derived from petroleum or natural gas

Illustration, Gary Fields

©1996 Nintendo

Petrochemicals

Using petroleum and natural gas, engineers have created synthetic materials used in various industries, including transportation, housing, and agriculture.

3 Petrochemicals are produced from petroleum or natural gas.

© Len Sirman

Nylon, used to make fishing line, parachutes, and waterproof fabric for raincoats, is made from petrochemicals.

First-stage petrochemicals are produced during petroleum refinement. They may be used as is or further transformed into other end products.

Petrochemicals have many different uses. Ammonia is a petrochemical used for agricultural fertilizer. In the housing industry, petrochemicals are used to make polyurethane insulation, polyvinyl chloride (or PVC) siding, carpeting, upholstery fabrics, paints, and wallpapers. Many medicines, including aspirin and acetaminophen, are derived from petrochemicals as well.

Toxic Wastes

Today the petrochemical industry faces environmental challenges. Factories that manufacture petrochemicals produce wastes that cause pollution. In addition, most materials made from petrochemicals are not biodegradable and continue to pile up in landfills.

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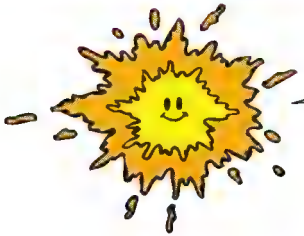
What heats a microwave oven?

SCIENCE AND TECHNOLOGY



1. Electromagnetic radiation
2. Kerosene
3. Solar radiation

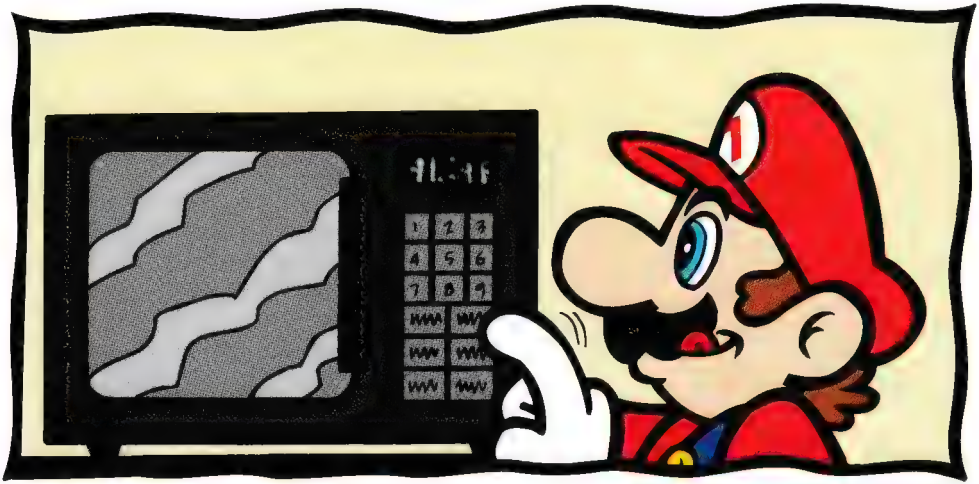


Illustration: Gary Fields

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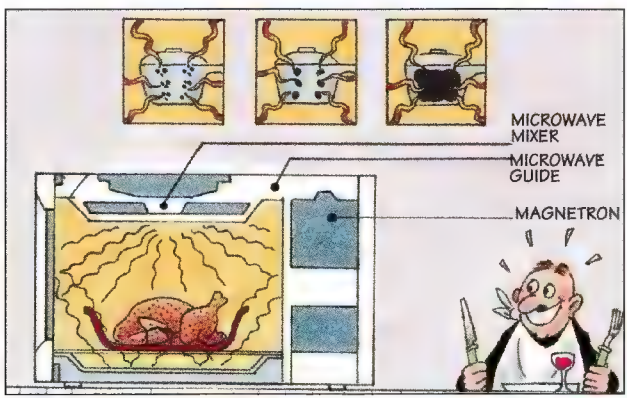
Microwaves

Microwaves are used not only for cooking food. They are also used in radio and television broadcasting, radar, meteorology, and satellite communications.

1 Microwave ovens heat food with electromagnetic radiation.



Microwave ovens make reheating leftover food easy and quick.

Microwaves are short, high frequency waves that exist in nature and are produced by the Sun. They lie on the same spectrum of electromagnetic radiation as visible light, ultraviolet light, and radio waves. Microwaves can also be generated by oscillators or magnetrons, solid-state devices in special electron tubes.

Microwave Ovens

Microwave ovens work by agitating the water molecules in food. These vibrating molecules produce heat, which cooks the food. Microwaves are created and sent in through the top of the cooking chamber. There, a stirring device scatters them evenly throughout the oven. Because microwaves cannot pass through metal containers, only ceramic, plastic, or paper containers can be used for cooking.

Exposure to high-intensity microwaves can be dangerous. Microwave ovens produce very low-intensity radiation and are subject to strict government regulations.

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What are the primary colors?

SCIENCE AND TECHNOLOGY

1. Red, yellow, and blue
2. Orange, purple, and green
3. Red, green, and orange

Illustration: Gary Fields

©1996 Nintendo

Primary Colors

If you've ever used oil paints or watercolors, you know that mixing two or more colors creates other colors. But you can't mix colors to create red, yellow, or blue.

1 The primary colors are red, yellow, and blue.

© Douglas Pulsipher, Third Coast Stock Source

Primary colors give these ordinary paper clips extraordinary appeal.

Red, yellow, and blue are the primary colors. They are the building blocks from which all other colors are made. Secondary colors are made by combining two primary colors: Red and yellow combined make orange, red and blue make purple, and yellow and blue make green.

Color in Culture and Religion

In addition to being beautiful, color can be symbolic. The founders of the United States chose the colors of the flag for their symbolic significance. They chose white for purity and innocence, red for hardiness and valor, and blue for vigilance, perseverance, and justice.

In some cases, different cultures attach different meanings to the same color. In the U.S., white is a symbol of purity, which is why brides usually wear white gowns. But in Japan, for instance, white is the color of mourning and is worn at funerals.

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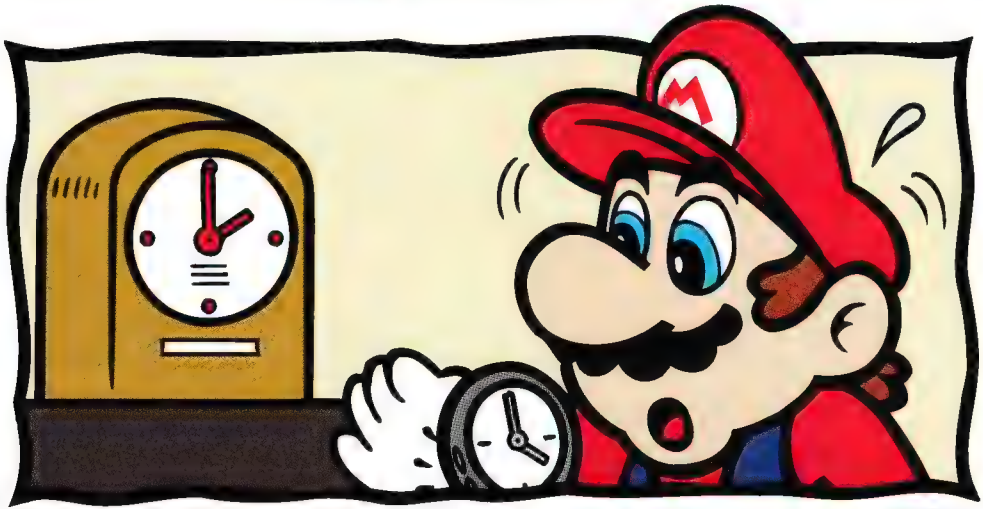
What is one of Switzerland's most important industries?

SCIENCE AND TECHNOLOGY

1. Shipbuilding
2. Logging
3. Watch-making



Illustration, Gary Freeds

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Watch-Making

French and Italian refugees introduced watch-making to Switzerland in the 16th century. By the 18th century, Switzerland had become the heart of the world's watch-making industry.

Watch making is one of Switzerland's most important industries.

© D. Goudouneix / Explorer

One of Switzerland's main industries is the manufacture of precision instruments, including the tools used in watch- and clock-making.

Even before the industrial era, Swiss-made products were known throughout Europe. Medieval Swiss cities had shops for printing and graphics, carpentry, watch-making, and machine tooling. The Swiss food industry developed many well-known items in an attempt to make nonperishable products from milk. Such items include Swiss and Gruyere cheeses, condensed milk, and chocolate.

Modern Industry and Work Force

Switzerland is one of the world's most highly industrialized countries. Most of its industry is located in the center of the country, near Zurich. The watch industry is based in Geneva and the Jura region.

Switzerland's work force is largely composed of foreign workers, primarily from Italy. The country's rate of unemployment is one of the lowest in Western Europe.

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Which was the first radio station?

SCIENCE AND TECHNOLOGY

1. BBC in London
2. KDKA in Pittsburgh
3. WNBC in New York

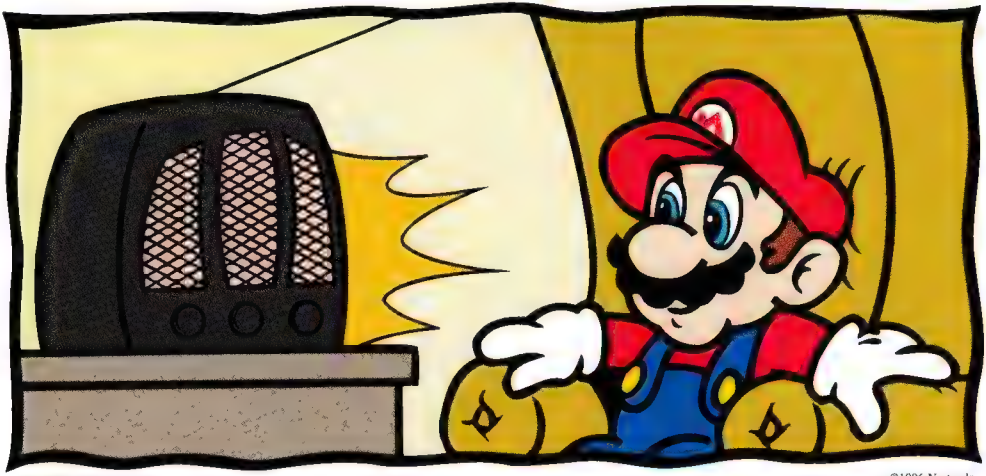

Illustration Gary Fields

©1996 Nintendo

Radio Stations

KDKA in Pittsburgh, Pennsylvania, is generally regarded as the world's first radio station. It began broadcasting on November 2, 1920. Its first broadcast was the result of the 1920 presidential election.

2 KDKA in Pittsburgh was the first radio station.

© FPG / Explorer Archives

Before television, families tuned in to radio broadcasts for news and entertainment. The first game shows and soap operas were broadcast on radio.

There were earlier experimental radio broadcasts, but when KDKA went on the air it made media history. Just a year after its first broadcast, there were 30 radio stations on the air. People bought radios for their homes so they could listen to music, news reports, and serialized programs. These daily or weekly shows were called "soap operas" because they were sponsored by soap companies.

Tuning In

Today there are thousands of radio stations in the U.S. Each is identified by call letters. Most stations east of the Mississippi River have call letters beginning with W, like WNEW, New York. West of the Mississippi, most station call letters start with K, like KABC, Los Angeles. If a station existed before this rule went into effect, it kept its call letters. So even though it's east of the Mississippi, KDKA still operates in Pittsburgh.

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Who physically proved the existence of radio waves?

SCIENCE AND TECHNOLOGY

1. Harry Harrison
2. Heinrich Hertz
3. Henry Higgins

Illustration: Gary Fields

©1996 Nintendo

Radio Waves

James Clerk Maxwell, a Scottish physicist, proved the existence of radio waves mathematically in 1873. Hertz used Maxwell's theory as the basis of his research.

2 German physicist Heinrich Hertz physically proved the existence of radio waves.

© D. Boiteau / Explorer

The unit of frequency used to measure radio waves is the hertz (Hz)—named for the man who proved their existence.

Scientific discovery often occurs when one scientist builds on work done by those before him. That's what Heinrich Hertz (1857-1894) did. In 1888, he pursued Maxwell's work.

Electrical Experiment

Scientists knew that electrical waves could travel through a wire. Maxwell said these waves didn't need a complete wire circuit to travel—they could jump across gaps in the circuit. Hertz tested the theory by building a circuit of two metal coils with a gap in between. When electricity ran through one coil, electromagnetic waves jumped the gap to the other coil. Then he set up a second receiver coil in a different part of the room. This coil also received the electromagnetic waves, proving they could travel over longer distances. Later, Guglielmo Marconi found a way to use these waves for communication. He called them radio waves.

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Who discovered the phenomenon of radioactivity?

SCIENCE AND TECHNOLOGY

1. Henri Becquerel
2. Albert Einstein
3. Bruce Morrow

Illustration Gary Fields

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Radioactivity

Henri Becquerel, a French physicist, discovered radioactivity almost by accident.

1 Henri Becquerel was the first to discover radioactivity.

© Y. Arthus-Bertrand / Explorer

Nuclear reactors produce radiation, which creates energy. But radioactive waves are harmful to humans. People who work in nuclear power plants must wear protective clothing.

After the discovery of X rays in the late 1800s, physicists were fascinated by light rays that could penetrate solid matter. Becquerel (1852-1908) wanted to see if fluorescent materials gave off X rays. For his experiment, he wrapped a piece of photographic film in black paper and placed a crystal of potassium uranyl sulfate—a fluorescent chemical—on top. Then he put it in the sun. Since the sun stimulated fluorescence, the chemical would give off rays. If they were X rays they'd penetrate the black paper and show up on the film. It worked! Then he discovered something else.

Penetrating Rays

He found the chemical didn't need sunlight to create penetrating rays. It was the uranium in the chemical itself that gave off the rays. They flowed steadily and had an atomic charge. French physicists Marie and Pierre Curie became interested in Becquerel's discovery, which Marie Curie called radioactivity. In 1903, Becquerel and the Curies shared the Nobel Prize in physics for their work in radioactivity.

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What is a lodestone?

SCIENCE AND TECHNOLOGY

1. A heavy boulder
2. A natural magnet
3. A rock used to grind corn

Illustration Gary Fields

©1996 Nintendo

Magnets

The mineral magnetite, a form of iron, will attract or cling to objects made of iron. It's a natural magnet found in Earth.

A lodestone is a rock with natural magnetic properties.

© Labat / Jerrican

Earth's metallic core is like a giant magnet. Magnets, or lodestones, in compasses are naturally attracted to the planet's magnetic North and South Poles.

Some magnetite, called lodestone, was used in ancient compasses. Attracted by Earth's natural magnetic field, a lodestone aligned itself with Earth's magnetic North and South Poles. A magnet's range of attraction is called its magnetic field. You can't see it, but you can feel it. Hold a refrigerator magnet about an inch away from the fridge and you'll feel it trying to pull itself closer to the refrigerator. That's the magnetic field at work! Hold it two feet away and you won't feel the attraction because you're outside the magnetic field.

Man-made Magnets

Electromagnets are a human invention. They're useful because they allow a person to turn the magnet on and off. An electromagnet is made from a piece of iron wrapped with electrical wire. Electricity running through the wire magnetizes the iron. When the electricity is turned off, the iron is no longer magnetized.

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How do compact disk players play disks?

SCIENCE AND TECHNOLOGY

1. With lasers
2. With phonograph needles
3. With tape heads

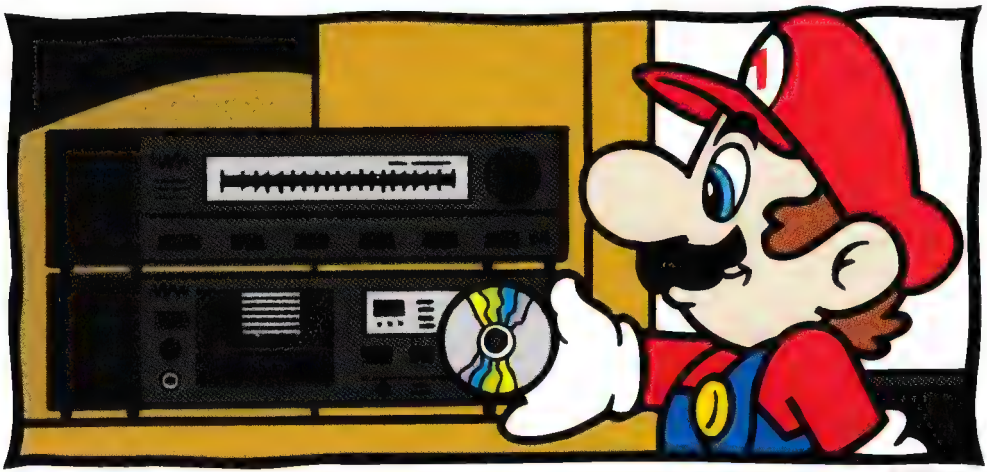

Illustration: Gary Fields

©1996 Nintendo

Compact Disks

The laser inside a CD player "reads" the pattern of bumps and grooves on a disk and translates them into sound.

1 A compact disk player uses a laser to read the music recorded on the disk.

© D. Mar / Explorer

Because the laser in a CD player never physically touches the disk, CD tracks don't wear out.

A CD is a plastic disk coat ed with metal to make it reflective, then coated again with a clear layer of plastic.

Digital Recording

Before the disk is coated with metal, music or sound is recorded on it. Imagine a singer's voice creating a pattern of invisible sound waves. CD recording equipment receives the electric impulses of the sound waves and converts them into a code made up of different combinations of the digits 0 and 1. This process is called digital recording. The code is then translated into a series of bumps and pits which are etched into the plastic disk. When the disk is coated with metal, the pattern is made permanent.

Laser Reading

Inside a CD player the disk spins very fast, and a laser shines up at the pits and bumps on the disk's surface. The reflective metal on the disk causes the laser light to bounce back down to a photodetector which reads the code on the disk and translates it back into the sound you hear.

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What causes rust?

SCIENCE AND TECHNOLOGY

1. Humidity in the air
2. Fungus
3. Old age

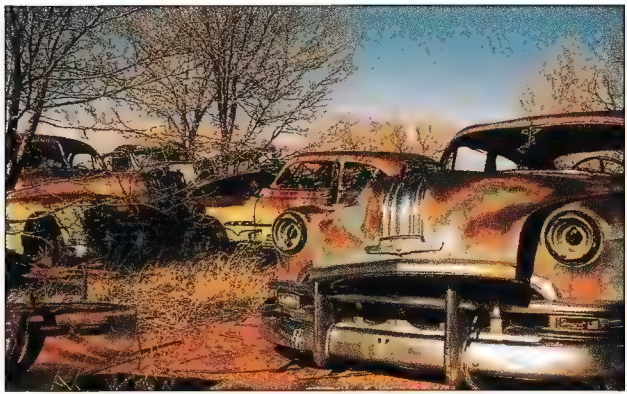
Illustration Gary Freeds

©1996 Nintendo

Rust

Iron, an element present in metals such as steel, is sensitive to humidity in the air. When this humidity, or moisture, is present, iron may rust.

1 Rust is caused by humidity in the air affecting metal.



© Len Sirman

Rust attacks iron-based metals that are exposed to oxygen and moisture.

For rust to be created, both water and oxygen must be present. Iron atoms in the metal attract atoms of oxygen and molecules of water, which eat away at the metal. This corrosion caused by oxygen is called oxidization. Rust's scientific name is ferric oxide, from the Latin word *ferrum,* meaning iron.

Rust-proofing

Rust attacks metals, like steel, that contain iron. Many are in your home. Household nails may be made of steel; steel girders are used in construction; outdoor furniture and railings are made from wrought iron; and most cars have steel frames. Once rust starts, it's hard to stop. That's why cars, and other metal surfaces exposed to air and moisture, are coated with rust-resistant paint. As long as the finish is intact, the surface is protected. But look closely at a car with chipped paint, and you might see rust forming on the metal beneath.

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Which building material is made from layers of thinly sliced wood?

SCIENCE AND TECHNOLOGY

1. Grout
2. Plywood
3. Sheet rock

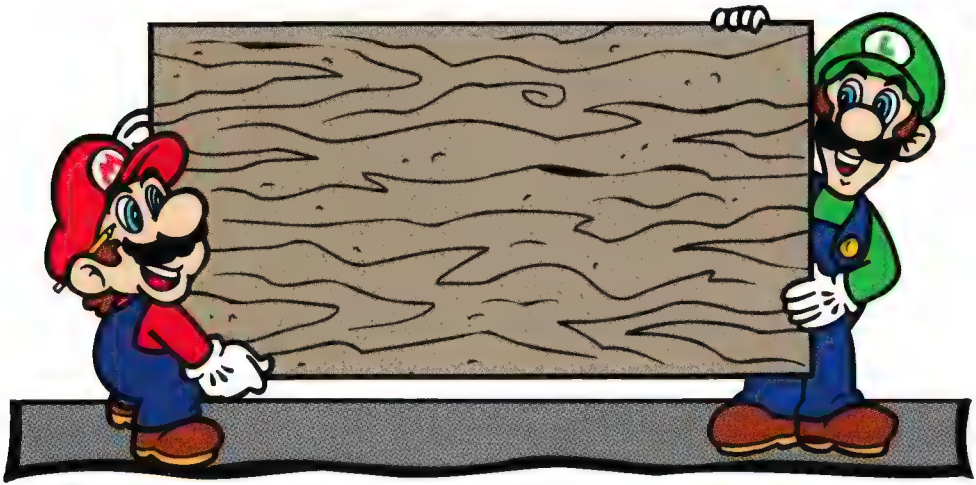

Illustration: Gary Fields

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Plywood

Ply is another word for layer. Plywood is wood made of many layers.

2 Plywood is made from layers of thinly sliced wood glued together.

© Hollyman / P. Resear / Explorer

Sheets of plywood are used in home construction. They also are used to make furniture, crates, and other common wooden items.

To find large sheets of wood for home and furniture construction, builders and carpenters once needed cut down the largest trees they could find and slice them into sheets. But it could take dozens of years for a tree to grow to the size needed to produce large sheets of wood. A faster method was needed.

Revolving Logs

The idea for plywood has existed since ancient times, but it took modern machinery in lumber mills to make production practical. To make plywood, a tree is cut down, stripped of its bark, and smoothed into a log. The log is then placed on a lathe—a sort of spindle that turns the log. As it turns, the log is pressed against a sharp blade that shaves off a continuous sheet of wood from it. The sheets are then stacked one on top of another and glued or bonded together, with the grain of one sheet at a right angle to the grain of the sheets above and below it. This strengthens the plywood and keeps it from warping or splitting.

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Which chemical product is made from pine trees?

SCIENCE AND TECHNOLOGY

1. Talc
2. Tar
3. Turpentine

Illustration Gary Fields

©1996 Nintendo

Plant Chemistry

Many of the chemical products we use at home are made from plants and trees. Even plastics can be made from plant products.

3 Turpentine is made from pine tree resins.

© J.-M. Emportes / Jerrican

Celluloid is a plastic made from a plant fiber called cellulose, mixed with camphor and alcohol. It is used to make photographic film, and dozens of household items—combs, buttons, and even toys.

Resins or oils are extracted from plants and combined with alcohol and other substances to make plastics, varnishes, adhesives, perfumes, and flavorings.

Sticky Sap

If you've ever had pine sap or resin your hands you know how difficult it is to wash off. That's because the resin is resistant to water. This is what makes it so useful to chemists. Pine resin is used to make varnishes which are painted on wooden surfaces to protect them from water damage. Turpentine, a chemical that dissolves paint and varnish, is also extracted from pine trees.

Fragrant Oils

Essential oils for perfumes, flavorings, and medicines, are extracted from trees and plants, and blended with alcohol. These oils in their pure form are strongly scented and harsh. They must be added to other "carrier" oils or solutions before they can be swallowed or applied to the skin.

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D3 054 59-18

Where was porcelain invented?

SCIENCE AND TECHNOLOGY

1. China
2. France
3. Germany

Illustration: Gary Fields

©1996 Nintendo

Porcelain

Porcelain is translucent. If you hold it up to light, the light shines through it.

1 Porcelain was invented in China.

© Lauros-Giraudon

In the 17th century, Holland traded actively with China and other Asian countries. Amsterdam, Holland's capital, became the leading center for Chinese porcelain importing.

The first porcelain was made in China in the 6th century. Potters mixed clay and the minerals feldspar and flint into a hard paste. Then they shaped it into vases, plates, and other items and let it air dry. It was painted with a glaze or decoration; then it was fired in a kiln, or oven, at an extremely high temperature until it was completely hard and the glaze was set.

Marco Polo's Discovery

After a journey to China, 13th-century Italian trader Marco Polo returned to Europe with porcelain. The nobility loved it. They even traded gold and silver for the new, exotic pottery. Though porcelain was well known in China, the method for making it was a closely guarded secret. Almost immediately, European potters set out to discover the secret of porcelain. Eventually, they developed their own slightly different method of production, known as soft-paste porcelain. Both methods are used today.

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What material is used to make bricks?

SCIENCE AND TECHNOLOGY

1. Asphalt
2. Clay
3. Quartz

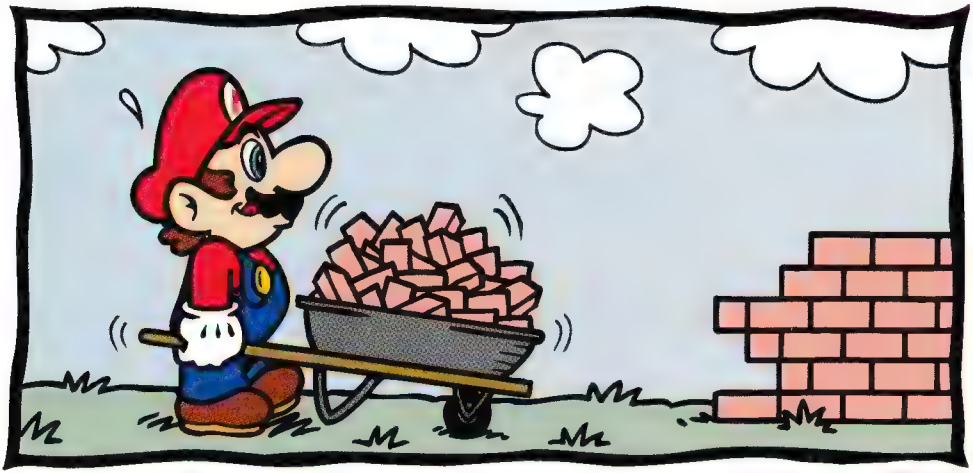

Illustration Gary Fields

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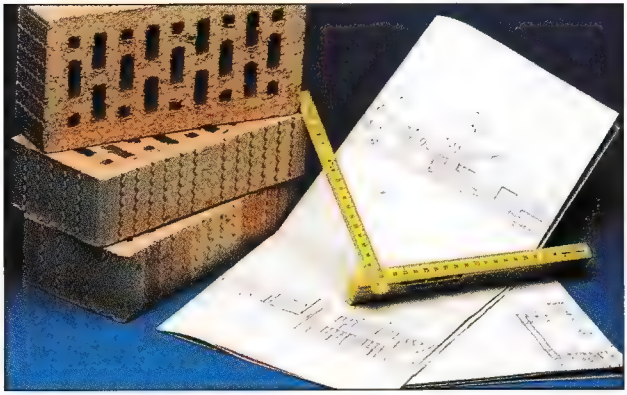
Bricks

Bricks get their red color from deposits of iron in clay. When clay contains lime or chalk, bricks made from it are yellow.

2 Bricks are made from clay.



Bricks are sturdy, long-lasting, and fire-resistant. They're used to build homes and public buildings all over the world.

© Len Sirman

Bricks are excellent building materials because they're strong, and easy and inexpensive to make. Even primitive cultures build brick structures.

Make and Bake

To make bricks, clay is dug from the ground and sifted to remove rocks and debris. It's mixed with sand to strengthen the bricks and keep them from crumbling. Water is added to make the clay easier to mold. The clay is shaped into rectangular blocks then baked in a kiln to harden it. In modern factories, bricks are cut and shaped by machines, but some brick makers shape bricks by hand the old-fashioned way.

Solar-Fired Bricks

Adobe brick, a favorite building material in Mexico and the southwestern U.S., is made from clay mixed with chopped reeds. In these hot, dry regions, brick makers don't need kilns to bake bricks. They simply set them in the sun to dry and harden.

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What are igneous rocks?

SCIENCE AND TECHNOLOGY

1. Rocks found only on islands
2. Rocks formed by volcanic activity
3. Rocks found only in Antarctica

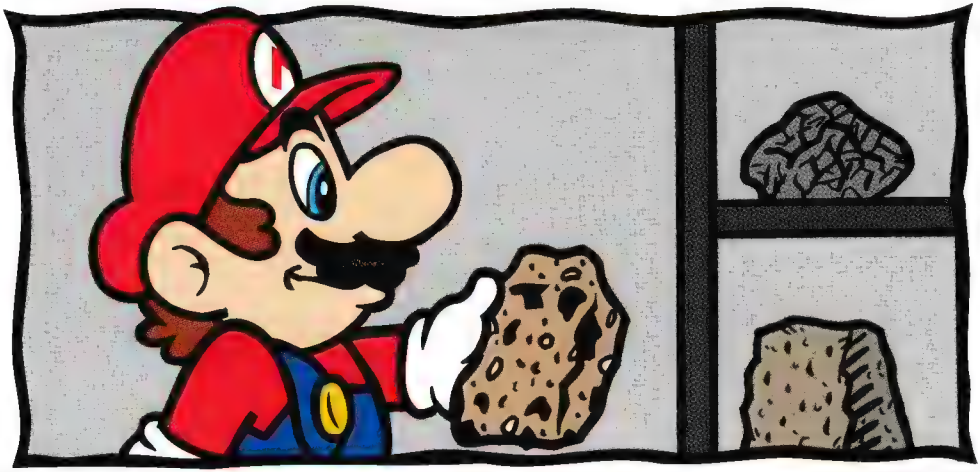

Illustration: Gary Fields

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Igneous Rock

The name igneous comes from the Latin word *ignis*, meaning fire. Igneous rocks come from Earth's fiery volcanoes.

2 Igneous rocks are formed by volcanic activity.

© Blumtzer / Diat

The perfect six-sided igneous rock columns at Giant's Causeway in Northern Ireland were formed by a lava flow. There are about 40,000 columns, ranging in height from 3 to 7 feet (1-2 m).

When lava or magma, the molten rock under Earth's surface, cools it becomes igneous rock. Rock formed by lava that bursts out of a volcano is called extrusive igneous rock. Rock formed from magma that remains below the volcano's surface is called intrusive igneous rock. The oldest igneous rock has been on Earth more than 3.5 billion years, but new igneous rock is formed every day.

Rock Formations

Geologists identify igneous rock by its mineral content and texture. Most igneous rock is basalt—formed from the minerals feldspar, augite, and olivine. Basalt is black and finely grained, and it sometimes collects in columns and unusual rock formations. Devil's Tower in Wyoming is a 867-foot-tall (264 m) tower of basalt formed when a lava flow cooled millions of years ago.

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What is metamorphic rock?

SCIENCE AND TECHNOLOGY

1. Rock from the moon
2. Radioactive rock
3. Rock that has changed its crystal structure

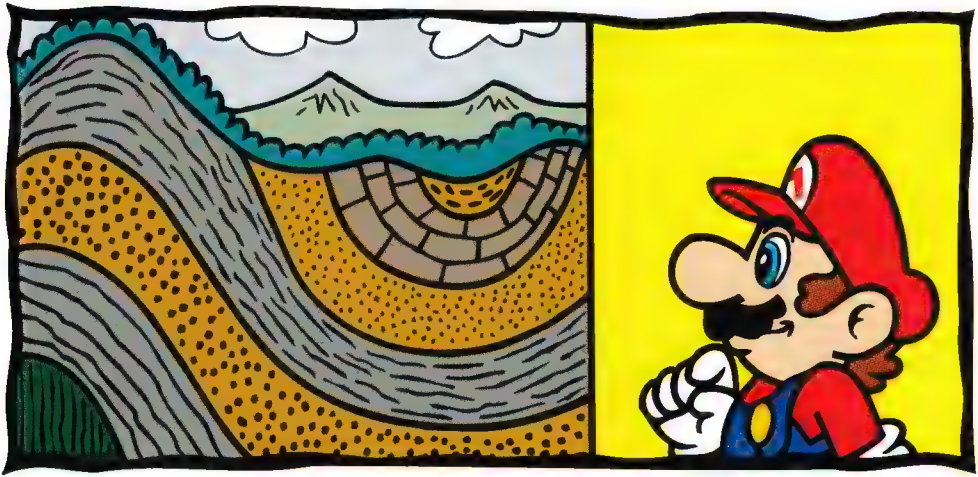

Illustration: Gary Fields

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Metamorphic Rock

Metamorphosis means change or transformation. These rocks began life in one form and changed to another.

3 Metamorphic rock is rock that has changed its crystal structure.

© Labat / Jerrican

Slate is a metamorphic rock created when the sedimentary rock shale is subject to pressure from within Earth. Metamorphosis causes granules of clay in the shale to recrystallize into smooth, flat layers of slate.

Rocks can change form when they are subject to intense heat or pressure. Intense heat can come from flows of magma—the molten rock beneath Earth's surface. Pressure is caused by plate tectonics—the constant shifting of Earth's shell.

Transformation

One way geologists identify metamorphic rock is by how densely its minerals are packed together. Sedimentary rock, for example, tends to be loosely packed, with pores throughout the rock. But when sedimentary rock is transformed into metamorphic rock it becomes more densely packed and mineral grains fill the pores. For example, the porous sedimentary rock limestone changes into the metamorphic rock marble. Limestone and marble have the same mineral content, but in marble the minerals are more densely packed.

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What are minerals?

SCIENCE AND TECHNOLOGY

1. Crystallized chemicals found in rocks
2. Small mountain streams
3. Underground geological labs

Illustration Gary Fields

©1996 Nintendo

Minerals

Minerals give rocks their character—density, hardness, and even color.

1 Minerals are the chemicals, in crystal form, that make up rocks.

© Len Sirman

When iron is extracted from the iron ore hematite, the mineral must be heated at extremely high temperatures to melt the metal and separate it from the rock.

Most minerals contain metallic elements, such as iron, tin, copper, or zinc. Those which contain metals that can easily be removed from them are called ores.

Iron Ores

Hematite, magnetite, and pyrite are iron ores. Hematite and magnetite, contain iron and crystallized oxygen. Pyrite contains iron and sulfur. Hematite is naturally dull gray, but when polished it shines like a metallic pearl and it is sometimes worn as jewelry. Magnetite is a natural magnet. Pyrite is sparkly and slightly golden. In fact, it's known as "fool's gold" because miners sometimes mistake the iron ore for precious metal.

Making Metal

The process of obtaining a metal from its ore is called extraction. The ore is heated at extremely high temperatures which cause the metal within it to turn to liquid. The liquid metal is then poured off from the rock. When it cools, the metal solidifies.

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What is chemistry?

SCIENCE AND TECHNOLOGY

1. Science of the composition and reactions of matter
2. Scientific study of earthquakes and volcanos
3. Study of human interpersonal relationships

Illustration: Gary Fields

©1996 Nintendo

Chemistry

All matter, from air to water to baseballs and bicycles, is made up of atoms of elements. You can't see them, but chemists know they exist.

Chemistry is the study of the composition and reactions of matter.

© Weiss / Jerrican

Chemists mix elements in different combinations and proportions to produce various industrial products, such as paints and coatings, plastics, and synthetic fabrics.

In a simple way, chemistry is like cooking. Chemists determine the elements, or ingredients, that make up various forms of matter. Mixing elements in different ways produces different forms of matter.

An element is a pure substance. You can't mix two or more substances to produce an element—in other words, it has no ingredients. Hydrogen, oxygen, and carbon are elements.

What's the Matter?

Atoms are tiny units of elements. A clump of atoms forms a molecule. Clumps of molecules form matter. Combine two hydrogen atoms with one oxygen atom and you get a molecule of water. Water's chemical formula is H_2O. Combine hydrogen and oxygen in different proportions, and add carbon, and you get glucose, or sugar. The chemical formula for glucose is $C_6H_{12}O_6$. Six atoms of carbon, twelve hydrogen, and six oxygen.

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Where are most of the world's oil reserves?

SCIENCE AND TECHNOLOGY

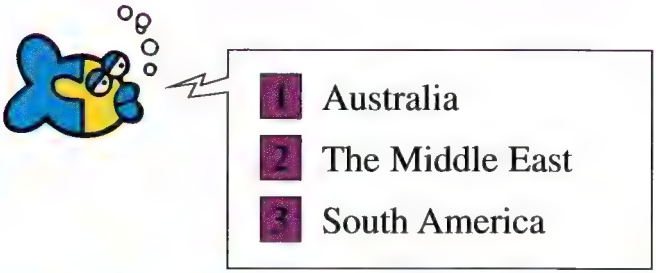

Illustration: Gary Fields

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Oil Reserves

The Persian Gulf region, which includes Saudi Arabia, Kuwait, Iraq, United Arab Emirates, and Iran, contains most of the world's oil.

2 Most of the world's oil reserves are in the Middle East.

© J. Burlot / Gamma

Beneath the deserts of the Middle East are the world's largest oil reserves. Saudi Arabia produces the most oil of any country on Earth.

Venezuela is also a major producer. It's the only nation outside the Middle East to be part of OPEC, the Organization of Petroleum Exporting Countries. Russia and Mexico also produce oil.

American Oil Country

Oil was first found in the U.S. in Pennsylvania. In 1901, the first productive oil well, or gusher, was drilled in Texas, and almost overnight Texas became our richest oil producing state. In the 1960s, America's largest oil reserve was found in Alaska, but by that time control of the oil industry had shifted to the Middle East.

Off-shore Drilling

Not all oil is found on land. There are large reserves under the North Sea and the Gulf of Mexico. Extracting this oil is called off-shore drilling. Huge platforms, or rigs, are built at sea and anchored to the sea floor to hold drilling equipment. Some rigs also have bunks to house the crew working on the rig.

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What can fiberglass be used for?

SCIENCE AND TECHNOLOGY

1. Car bodies and insulation
2. Fertilizer
3. Food

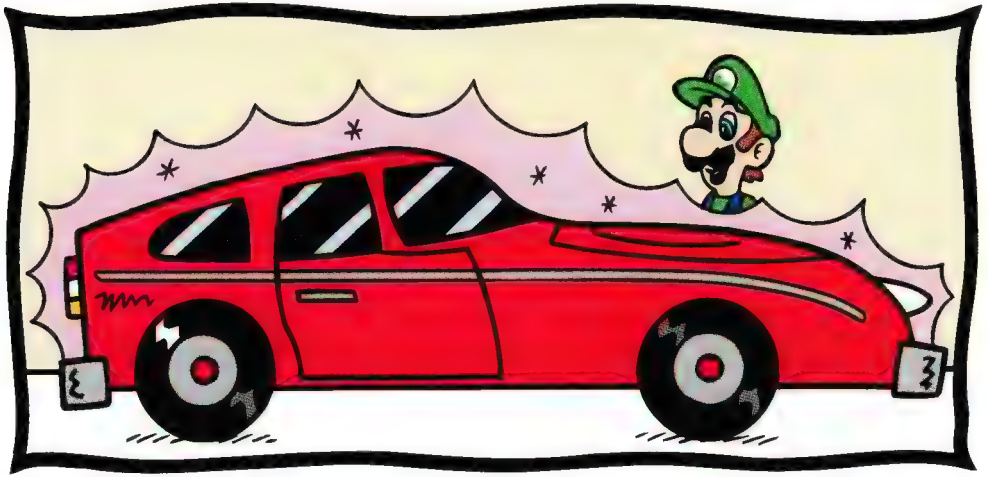

Illustration: Gary Fields

©1996 Nintendo

Fiberglass

Lightweight and water-resistant, fiberglass is a useful modern material. It's made of very thin fibers of glass.

1 Fiberglass is used for car bodies and insulation.

© C.B. Smith / Sipa-Press

Lightweight fiberglass is used to make the bodies of racing boats.

Glass blowers in ancient Egypt and Rome stretched molten glass into long, thin strands or fibers which they used to decorate glass objects.

Fabric from Glass

In the 19th century, a technique was developed for weaving the fibers into fabric. The trouble was that it took a long time and had to be done in a hot room to keep the glass fibers soft and flexible. Eventually, the original looms were replaced with metal drums that could draw and weave many strands at the same time. Now fiberglass fabrics are used for fireproof curtains, and wooly fiberglass is used as insulation.

Mixed with Plastic

The fiberglass used in the bodies of cars and boats is mixed with plastic. It resists rust, and the glass fibers reinforce the plastic to make it stronger and less likely to crack or dent. Fiberglass is also used to make tennis rackets and bows for archery.

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D3 054 62-08

Which was invented before the telephone?

SCIENCE AND TECHNOLOGY

1. Telefax
2. Telegraph
3. Television

Illustration: Gary Fields

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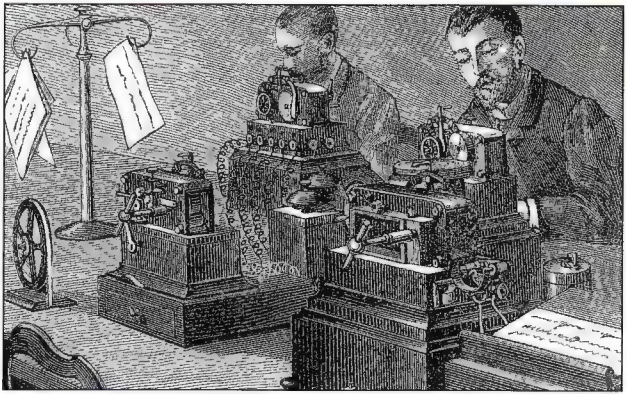
Telegraph

Before the invention of the telephone, long distance messages were sent in code using a telegraph.

2 The telegraph was invented before the telephone.



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Telegraph operators sent and received messages written in Morse code, a system of dots and dashes that represented letters.

A telegraph machine was a terminal connected to electrical wires. By pressing a key, the telegraph operator sent impulses over the wire. The impulses were received by another telegraph machine at another location. Telegraphs were revolutionary because they allowed accurate point-to-point communication over long distances—even across the ocean.

Dots and Dashes

Operators used a coded alphabet of dots—short taps—and dashes—longer taps—to spell out messages. American inventors Samuel Morse and Alfred Vail created the dot-dash language known as Morse code. Many inventors aided the development of the telegraph. Thomas Edison created a way for more than one message to travel over the lines at the same time. But with the invention of the telephone, which allowed long distance voice communication, use of the telegraph became less practical and today telegraphs are rare.

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Who invented the ball-point pen?

SCIENCE AND TECHNOLOGY

1. Hungarian journalist Laszlo Biro
2. American inventor Thomas Edison
3. English playwright Harold Pinter

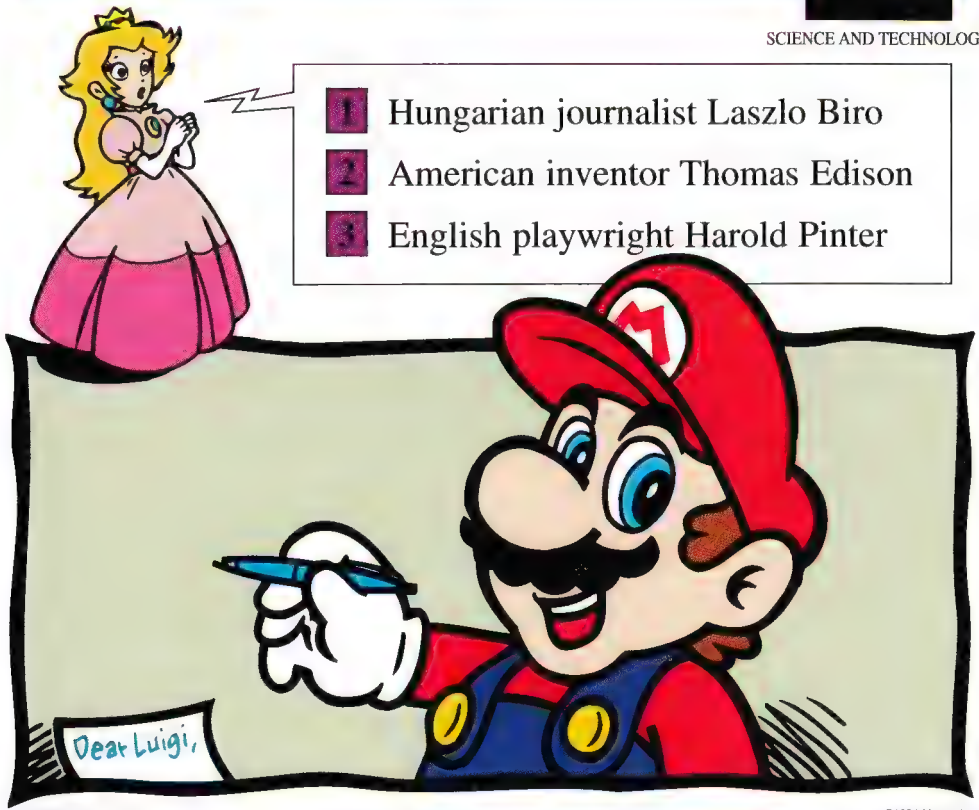

Illustration: Gary Fields

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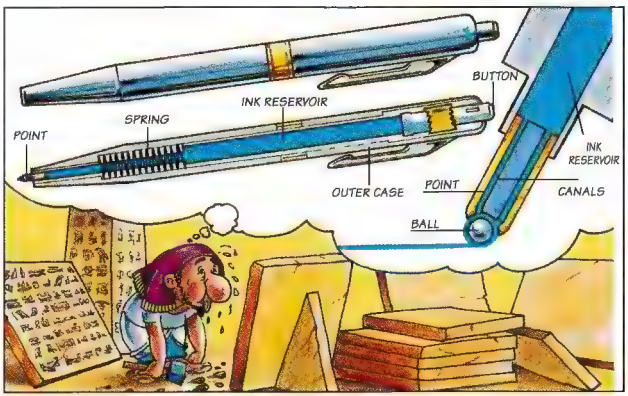
Ball-point Pen

Biro introduced the ball-point pen in the 1930s. In Europe, ball-point pens are known as biros.

Laszlo Biro, a Hungarian journalist, invented the ball-point pen.



Inside a ball-point pen. As the ball rolls, it pulls ink from the reservoir onto the point.

The fountain pen was invented by American insurance salesman Louis Waterman. It was an improvement over earlier pens that had to be dipped in ink, but it was messy. Early models had to be filled using an eye-dropper. Even when a self-filling cartridge was developed, the ink took a long time to dry. Every page had to be blotted to keep it from smudging.

Mother of Invention

For Laszlo Biro, frustration was the mother of invention. He used fountain pens to correct manuscripts, and he hated the mess they made. With his brother Georg, he designed a pen that wouldn't smudge.

Good Idea Made Better

John Loud, an American inventor, had already patented a ball-point pen made to write on rough surfaces. The Biros adapted Loud's design with a thin tube of ink inside. As the ball rolls, it draws ink from the tube and distributes it on the page.

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What is the wire inside a light bulb called?

SCIENCE AND TECHNOLOGY

1. Filament
2. Fuse
3. Luminary

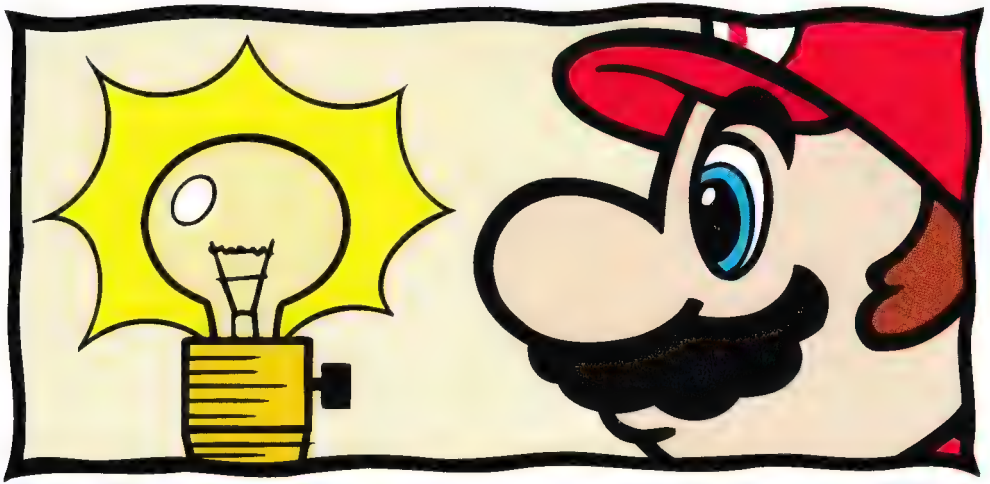

Illustration Gary Fields

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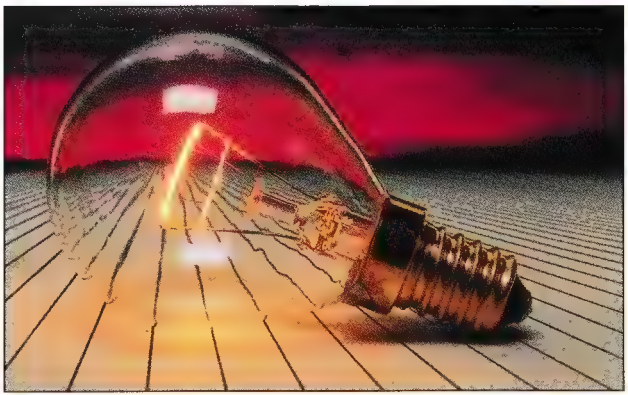
Light Bulb

Filaments are usually made of tungsten, a metal with a high melting point.

1 The wire inside a light bulb is called a filament.



© Kosel-Schuster / Explorer

Light bulbs are filled with gas that protects and preserves the filament.

Electricity heats the filament and causes it to radiate energy in the forms of light and heat. Illuminated light bulbs can be extremely hot—as much as 450°F (230°C).

Inside the Bulb

The filament becomes so hot that it would disintegrate or burst into flame if it were exposed to oxygen. So, inside the bulb a special environment is created to protect and preserve it.

In low-wattage bulbs, like those used for night lights, the inside of the bulb is a vacuum—free of oxygen.

When stronger light is called for, gas-filled bulbs are used. Ordinary household bulbs are filled with nitrogen and argon gases which allow the filament to be heated to higher temperatures thus producing brighter light.

Halogen bulbs produce the brightest, whitest light because the filament is heated even more. These bulbs are made of fused quartz, which withstands more heat than glass.

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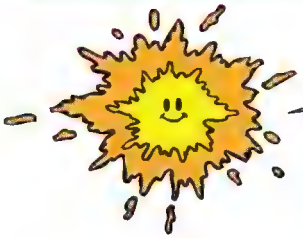
Where was the first patented can opener invented?

SCIENCE AND TECHNOLOGY



1. Manchester, England
2. Paris, France
3. Waterbury, Connecticut

Illustration: Gary Fields

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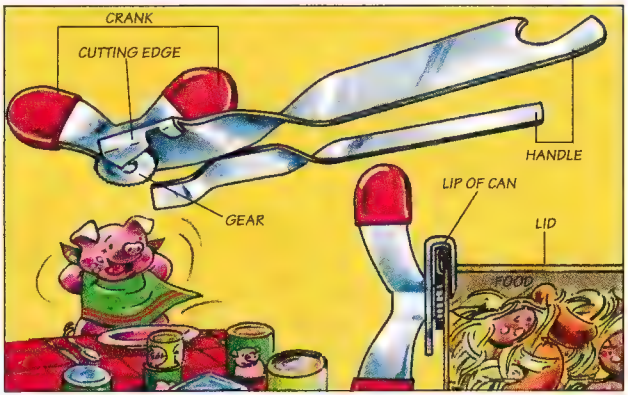
Can Opener

Food was packaged in cans as early as 1810, but it took almost fifty years for someone to invent a device to open them!

5 The first patented can opener was invented in Waterbury, Connecticut.



© Y. Tabarés

The sharp cutting edge of a can opener punctures the top of the can. Two gears grasp the can. Turning the crank drives the gears around the lip of the can and drags the cutting edge around the rim.

In 1810, Peter Durand of London, England, devised a way to package food in tin cans. Cans—or "tins" as they're called in England—were perfect for military rations. They stored easily and protected food from damage and spoilage. Durand became successful selling canned food to England's Royal Navy during the War of 1812.

Piercing Discovery

Soldiers and sailors used any tools they had to open tin cans—bayonets, knives, even rifle fire! In the U.S., cans were used for rations in the Civil War, and later for household foods. To make cans convenient for home use, an easy-to-use opener was needed. Ezra Warner of Connecticut, patented a can opener in 1858. It was sharp and dangerous to use, but it was a start. In 1870, American inventor William Lyman improved it by adding a rotating cutting wheel, similar to today's can openers.

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What is an anvil used for?

SCIENCE AND TECHNOLOGY

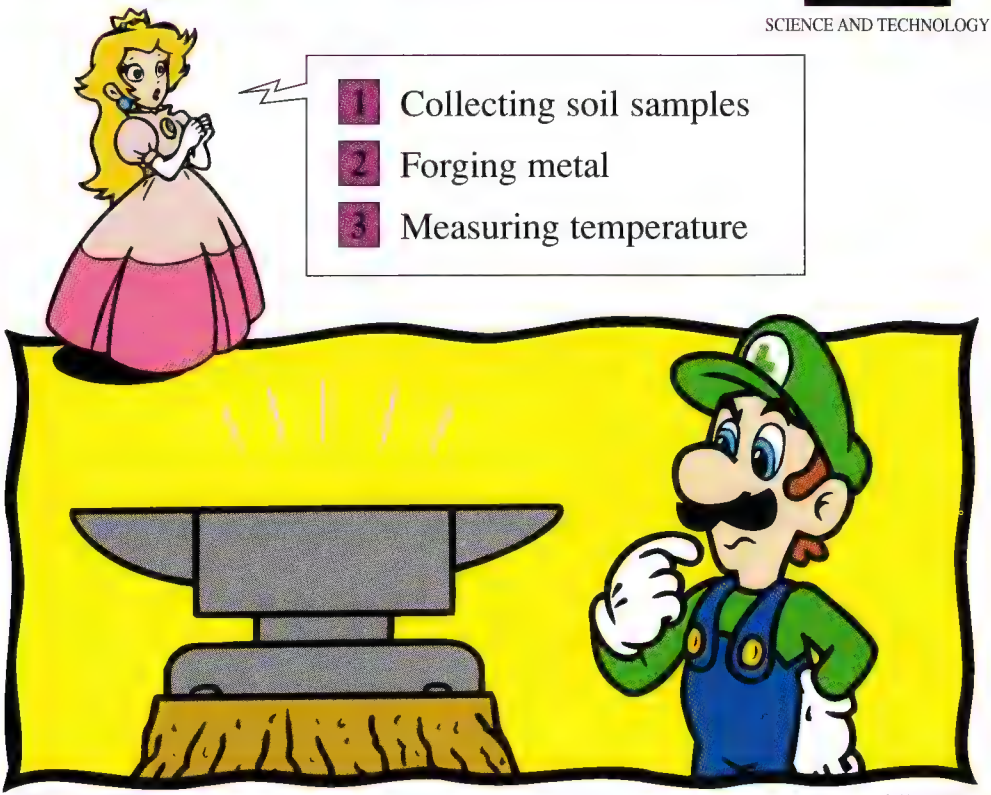

Illustration: Gary Fields

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Forge

A forge is a type of factory where metal is shaped or molded into useful items. Iron is the most commonly forged metal, but copper, aluminum, and other metals may be forged as well.

2 **An anvil is used to forge, or shape, metal.**

© Len Simman

In modern forges, mechanical hammers and presses are used to shape red hot blocks of iron into useful items.

Old-time forges were the workshops of blacksmiths: craftsmen who forged iron. They got their name from the black iron items they produced.

Heavy Metal

A hammer and anvil were the tools of the blacksmith's trade. An anvil is a heavy, flat-topped iron or steel block. In a huge furnace, the blacksmith would heat a piece of iron until it was red hot and glowing. He'd use long tongs to remove the iron from the fire, and place it on top of the anvil. Then, with a heavy metal hammer, he'd pound the hot iron flat and shape it into horseshoes, latches, tools, and other useful items.

Modern Forges

In today's forges, iron is shaped by mechanical hammers. It may also be pressed into molds, called dies, to make uniformly shaped pieces.

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What is an alloy?

SCIENCE AND TECHNOLOGY

1. A collection of geological specimens
2. A blend of metals
3. A computer used to solve equations

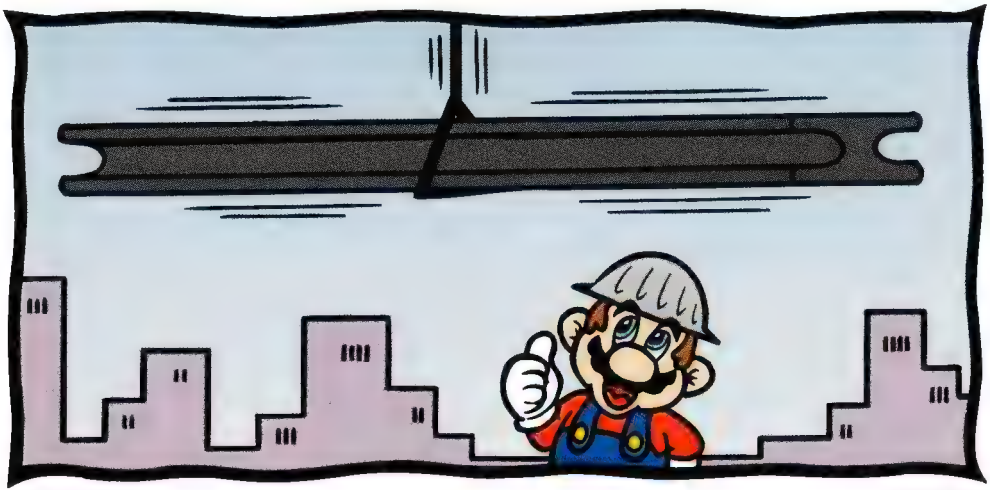

Illustration: Gary Fields

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Alloy

In an alloy, two or more metals are blended to create a stronger, more resilient, or improved form of metal.

An alloy is a blend of metals.

© BSIP Alexandre

Chew on this: The metal a dentist uses to fill your teeth or to make crowns that replace broken teeth is a special type of alloy called an amalgam.

Every metal has its own set of characteristics, or properties. Some are strong and can bear a lot of weight without bending or breaking. Others are exceptionally resistant to heat. Others conduct electricity well. By blending different metals together in an alloy, metallurgists take the most desirable properties of each and create a new, improved form of metal.

Tougher than Iron

Iron is a strong metal, but adding carbon to it makes iron even stronger. Blending iron and carbon produces the alloy known as steel. To counteract the iron's tendency to rust, metallurgists sometimes blend iron with carbon, chromium, and nickel. This produces the rust-resistant alloy called stainless steel. To build airplanes and rockets, engineers needed a metal that was strong and lightweight. So, titanium alloys were created. They're strong and corrosion-resistant, but they weigh much less than steel.

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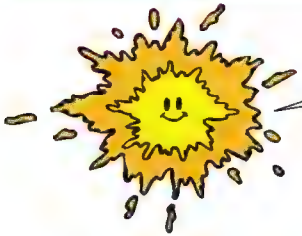
What protects overhead wires from damage by lightning?

SCIENCE AND TECHNOLOGY



1. Ground wires
2. Metal cages
3. Umbrellas

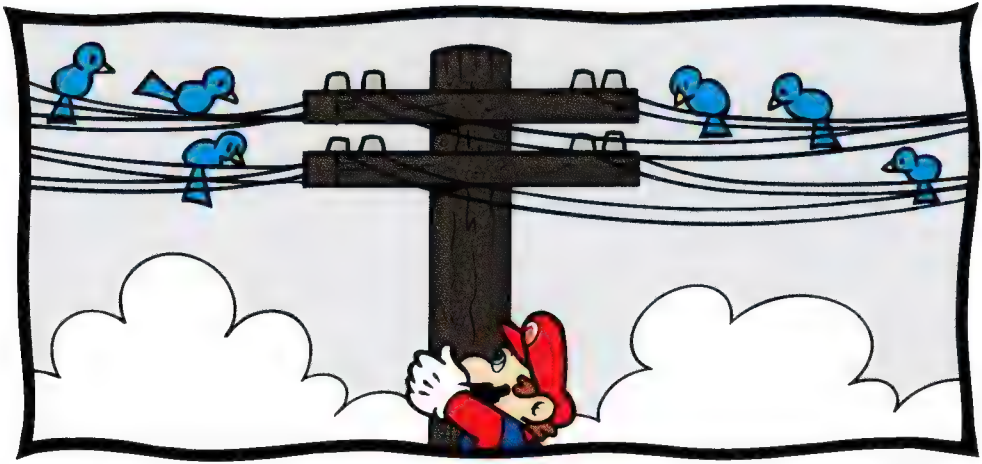


Illustration: Gary Fields

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Grounding

A sudden surge of electricity, like the charge from a lightning bolt, can damage electrical wires and cause power outages. Grounding protects against electrical surges.

1 **Ground wires protect overhead wires from damage by lightning.**

© Len Sirman

High-tension electrical wires must be grounded to protect them from sudden surges of electricity.

A ground wire is an insulated wire that is attached to a primary power line. Grounding is especially important on high-tension, overhead power lines. Since these lines are attached to tall poles or structures, they're easy targets for lightning damage. If the power lines are struck by lightning, the ground wires drain off the excess charge so the main lines can continue to function normally.

On Home Ground

The electrical system in your home is grounded, too. Ground wires inside electrical sockets and light fixtures ensure that metal parts don't cause electrical shocks or fires. Three-pronged grounded plugs, such as those on air conditioners and refrigerators, ground the appliances themselves.

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Where were the first glass mirrors made?

SCIENCE AND TECHNOLOGY

1. Katonah, New York
2. Sapporo, Japan
3. Venice, Italy

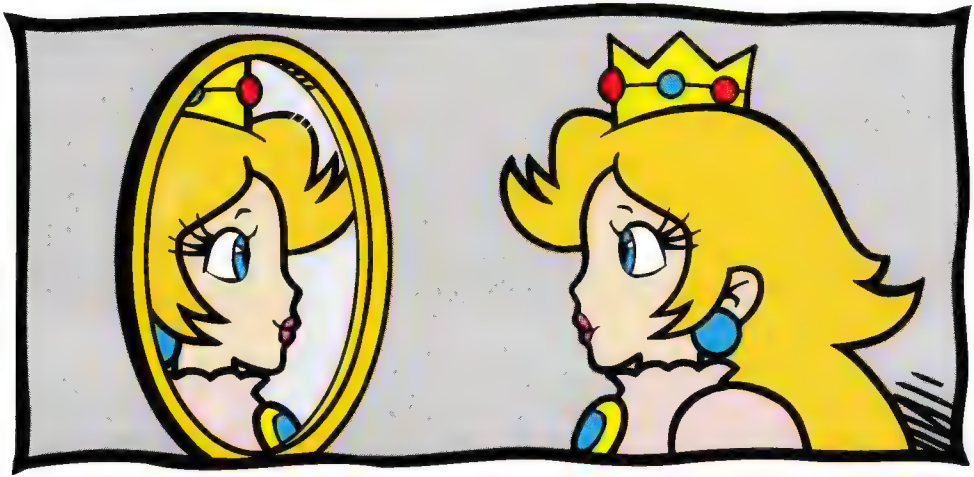

Illustration: Gary Fields

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Mirrors

Today, most mirrors are made from a sheet of glass coated with a thin layer of silver, which makes them reflective.

3 Glass mirrors were first made in Venice, Italy.

© R. Buchler / Option Photo

Most household mirrors are made from a sheet of glass coated on one side with silver. Car mirrors are usually coated with lead sulfide. Telescope mirrors are usually coated with aluminum.

The first mirrors date back to ancient Mesopotamia around the year 3500 BC. They were made of highly polished bronze, which reflected with a golden tint. Archaeologists have unearthed many examples of ancient mirrors set into beautifully carved handles of ivory, bone, and wood. Around 100 BC, ancient Romans used polished silver as mirrors. They preferred silver because it reflected true colors.

Venetian Glass

Venice, Italy, has always been known as one of the world's finest glass-making cities. Around 1300, Venetian glass blowers experimented with a technique of rolling or pouring out glass into flat sheets then coating it with silver to make mirrors. It was hard to do, and the glass was often distorted, but these early glass mirrors became a status symbol. People even wore them around their necks on chains as a sign of wealth.

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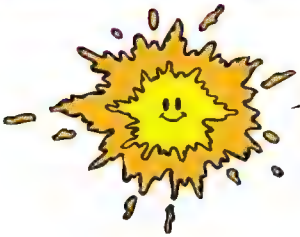
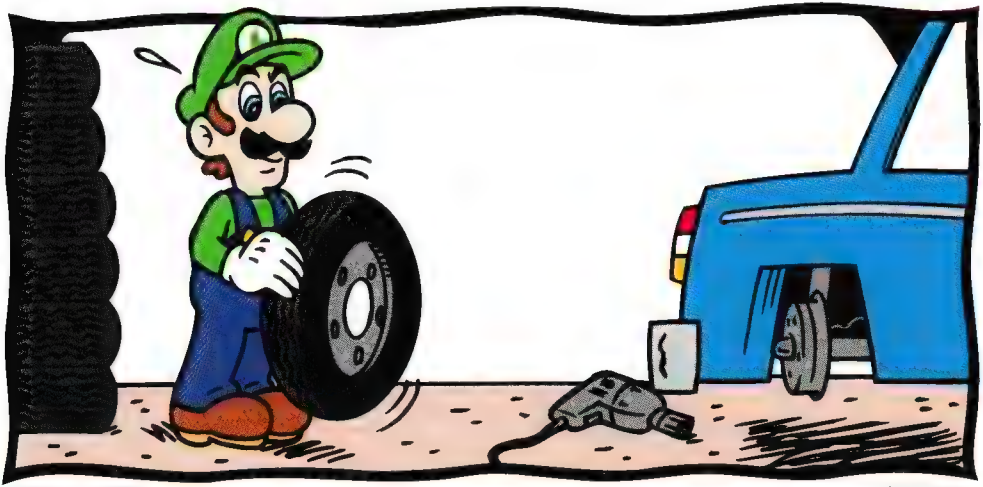
Who was the first to produce cars on an assembly line?

SCIENCE AND TECHNOLOGY



1. Karl Benz
2. Henry Ford
3. Ransom E. Olds



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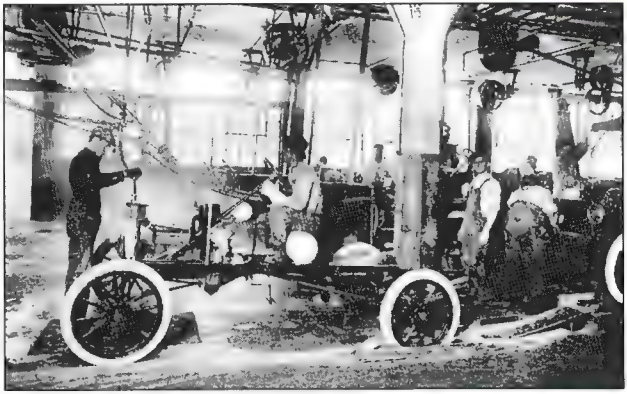
Assembly Line

On an assembly line, each worker is responsible for just one task. This speeds up production.

2 Henry Ford was the first to produce cars on an assembly line.



© Boyer-Viollet

Ford streamlined automobile production with the assembly line. He also made production more efficient by limiting choices. You could buy a Model T Ford in any color you wanted—as long as it was black!

The first cars, made around 1900, were too expensive for most people to afford. Henry Ford realized he had two choices when it came to increasing business. He could sell a few cars at a high price, or he could sell a lot of cars at a lower price. Ford knew that he'd make a lot more money if he could sell a lot of cars at a low price.

Production Costs

To cut the price of his cars Ford had to figure out how to manufacture them at a lower cost. He did this by making production more efficient. Instead of employees working on every part of the car, each person was given a specific task. Workers stood in one spot while the parts they needed rolled past them on an assembly line. Ford streamlined production so well that workers could build an entire car in just 93 minutes! In 1908, the Ford Motor Company made and sold 11,000 cars. Six years later, with the assembly line in place, Ford made and sold 248,000 cars.

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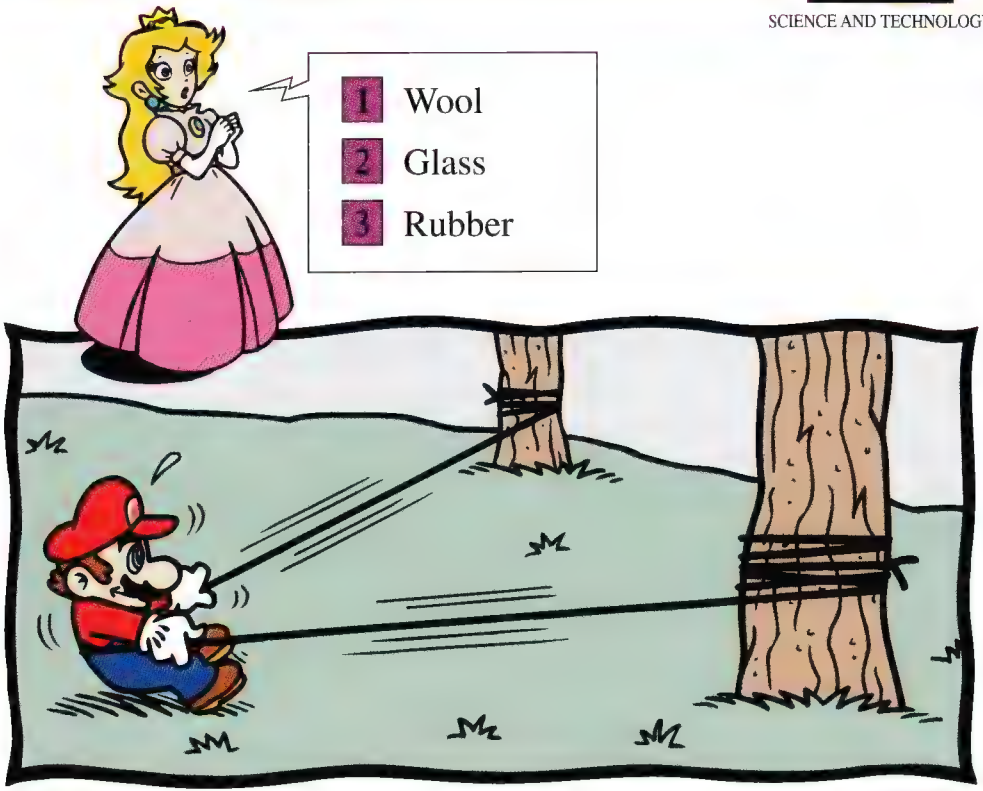
Which material is elastic?

SCIENCE AND TECHNOLOGY



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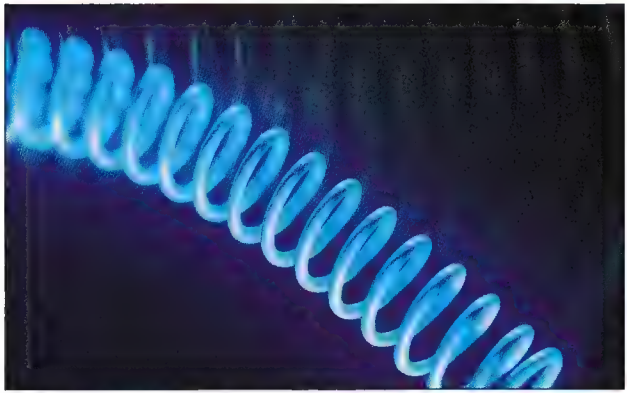
Elasticity

Solid materials that can be stretched or molded, and then immediately return to their original shape are said to be "elastic."

3 Rubber is elastic.



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Coiling a piece of wire into a spring increases the wire's elasticity.

You can stretch a rubber band pretty far, but when you stop stretching it returns to its original shape. That's elasticity.

When you stretch the rubber band, you are applying force to it—the force of your pulling. Elasticity is defined as the ability of an object to change shape when force is applied and to return to its natural shape when force is removed. If you applied the same amount of force to a different type of object, a piece of paper for example, you'd simply pull it apart. This is because paper is not elastic.

Adding Elasticity

Some objects can be made more elastic by changing their shape. A straight piece of wire, for example, has very little elasticity. But if the wire is coiled into a spring it can take the force of pulling or pushing and then return to its original shape when the force is removed.

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Which is a tool that cuts wood?

SCIENCE AND TECHNOLOGY

1. Hammer
2. Saw
3. Wrench

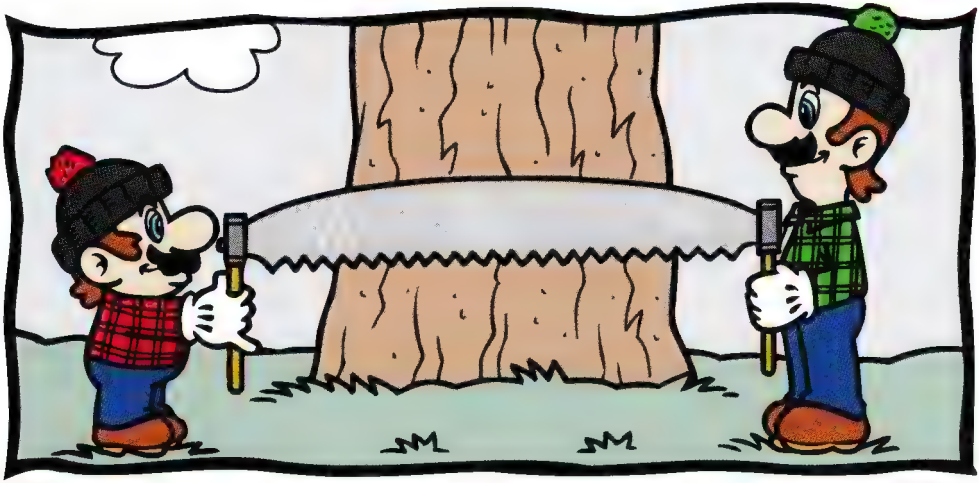

Illustration: Gary Fields

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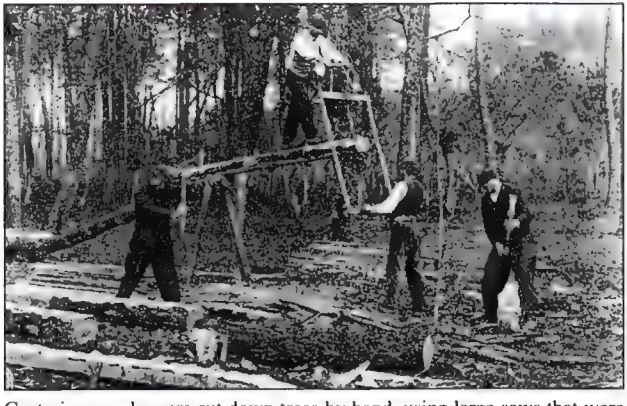
Saw

Archaeologists have found examples of saws made from sharpened stones by prehistoric humans.

A saw is a tool that cuts wood.



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Centuries ago, loggers cut down trees by hand, using large saws that were pushed and pulled by two workers. Today, this work is done with motorized chain saws.

Saws we use today have metal blades with very sharp teeth that dig into a piece of wood and rip it apart. A carpenter's saw is easy to recognize. It has a triangular blade with a handle, made of wood or plastic, at one end. It's made to cut through thick planks and boards. For cutting around curves, a carpenter uses a coping saw. Coping saws have very narrow blades attached to metal frames. They're lightweight and easy to maneuver.

For outdoor gardening, landscapers use pruning saws with curved blades made to fit the contours of tree branches.

Special Saws

People who cut large quantities of wood usually use motorized saws, like chain saws, that can cut through thick tree trunks with lots of power. Furniture-makers and professional carpenters use motorized table saws. Saws are part of a plumber's tool kit, too. The heavy-duty blade of a hacksaw is made to cut through metal pipes.

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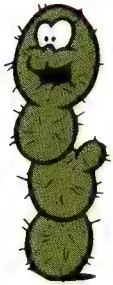
Why doesn't a top spin forever?

SCIENCE AND TECHNOLOGY



1. Air creates friction, which makes it stop
2. A top can only spin 100 times
3. Its point becomes dull and it stops

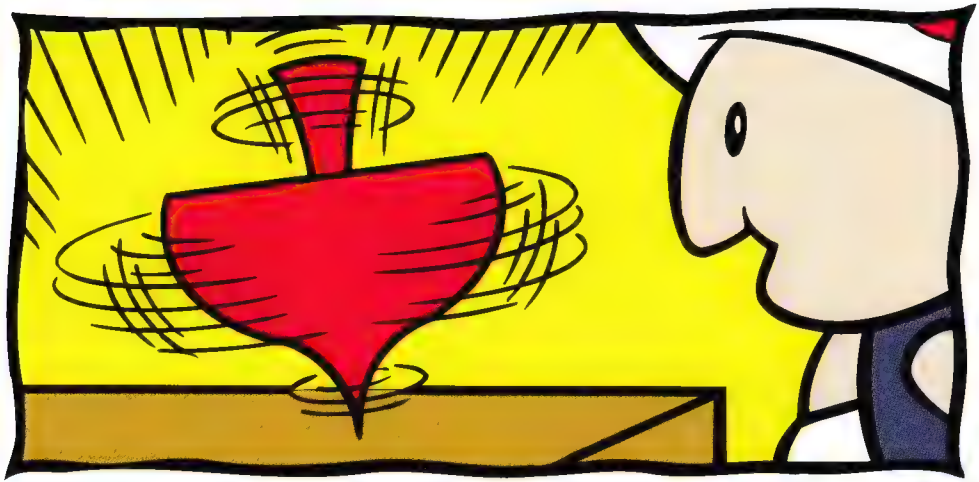


Illustration Gary Fields

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Top

A rotating object, such as a top, will keep on spinning until an outside force causes it to stop. Air creates the force that causes a top to slow down, and then stop spinning.

1 **Air creates friction, which makes the top stop spinning.**

© Valdin / DIAF

A simple spinning top works because of the scientific principles of centrifugal and centripetal force, equilibrium, and motion. Most kids just like tops because they're fun to play with.

The top is one of the world's oldest toys. It is was probably invented in ancient China. Even though the top is a simple toy, it works because of complicated scientific laws.

Physics

If you drew a line through the top's center point this would be the top's axis. Because the top's weight is balanced on all sides of the axis, the top spins perfectly upright and evenly. This state of being perfectly balanced is called equilibrium. If its weight was not balanced, the top would spin in a lopsided way. Centripetal and centrifugal force keep the top spinning vertically even if the surface it's spinning on changes position. Spin a top on a cafeteria tray, then pick up the tray while the top is spinning. The top still spins upright. Tilt the tray slightly and top will continue to spin upright. These are the laws of physics at work.

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How fast does a camera's shutter open and close?

SCIENCE AND TECHNOLOGY

1. A fraction of a second
2. Two seconds
3. One minute

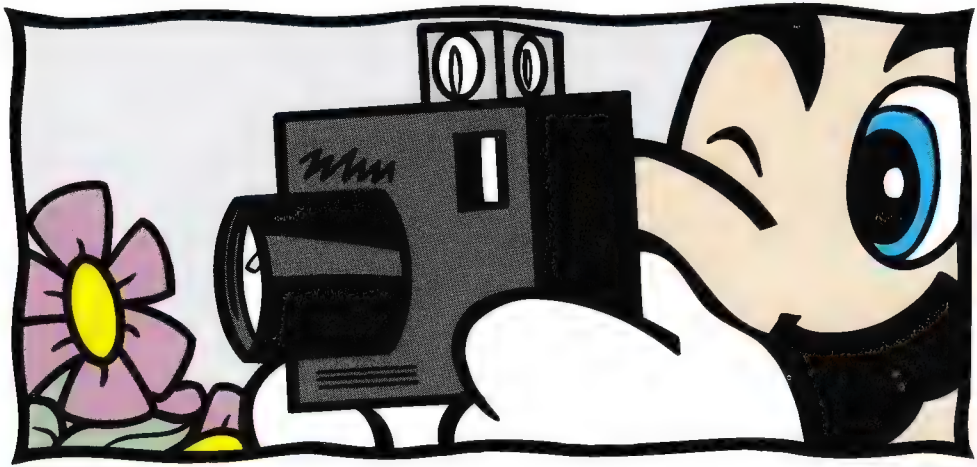

Illustration: Gary Fields

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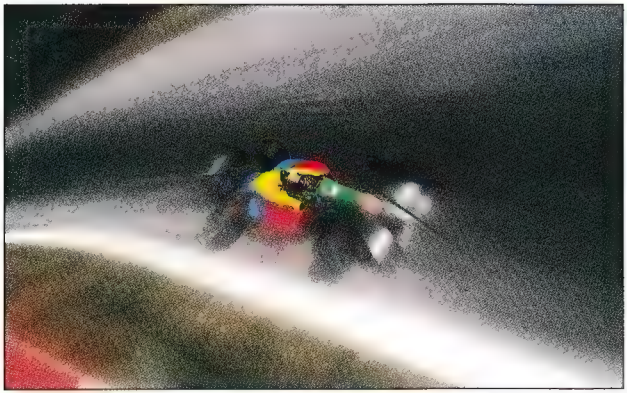
Shutter

A camera's shutter opens to let light enter the camera. The light hits the film and captures an image. It all happens in the blink of an eye!

1 A camera's shutter opens and closes in a fraction of a second.



© D. Leroy / Explorer

A camera's shutter can open and close fast enough to capture a speeding race car in action.

Pressing the button on top of a camera activates the shutter. It opens and closes in a fraction of a second to allow light to enter the camera's lens and hit the film. The precise moment that light hits the film is the moment that is frozen in time on a photograph.

Shutter Speed

Professional photographers use cameras that allow them to adjust the shutter speed. A typical shutter speed is 125, which means that the shutter opens and closes in 1/125th of a second. For taking action photos, the shutter speed might be even faster.

Race cars circling a track look like blurs to your naked eye as they whiz past you. But a camera is capable of capturing the action and freezing it, if the shutter moves fast enough. A camera's shutter can open and close in as little as 1/1000th of a second to capture fast action on film!

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What does photographic film's ISO number tell you?

SCIENCE AND TECHNOLOGY

1. The number of exposures it contains
2. Whether it's for black-and-white or color photos
3. Its sensitivity to light

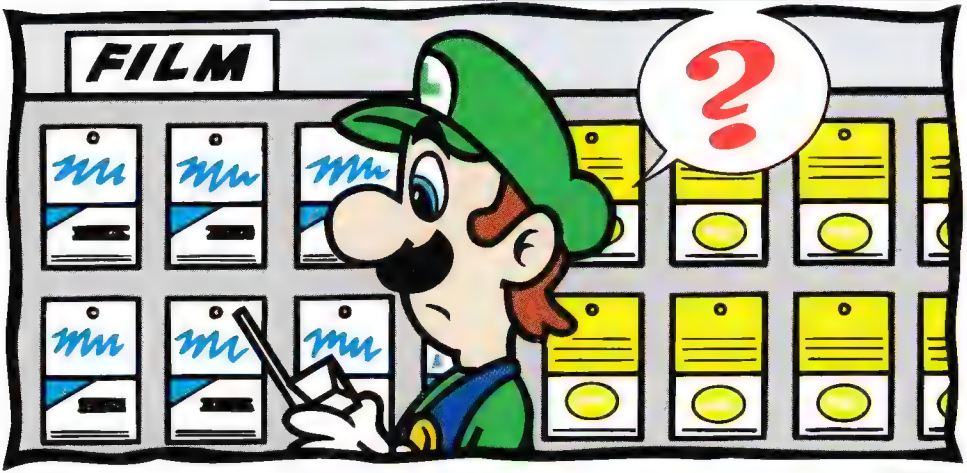

Illustration Gary Fields

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Film

Different types of film are made to be used in different lighting conditions. Some work best in full daylight. Others can be used indoors, or in dim light.

3 Film's ISO number indicates its sensitivity to light.

© Kremmer / Option Photo

The ISO number is clearly marked on canisters of film. Most of these are ISO 100. Can you spot the numbers?

Photographic film is made from strips of plastic coated with a light-sensitive chemical compound called an emulsion. When light hits the film, it causes chemical changes in the emulsion which result in an image being imprinted on the film. This image becomes what you see when the photograph is developed. Different emulsions require different amounts of light to make the chemical reaction occur. Some need the full force of bright daylight. Other emulsions are more sensitive to light so they require less light to produce the same chemical reaction.

What's Your Number?

An ISO number indicates how much light the film requires. (ISO stands for International Standards Organization, which created the scale used to classify film.) The lower the ISO number, the more light it needs. So, ISO 100 film needs four times as much light as ISO 400 film.

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Which opening regulates the amount of light entering a camera?

SCIENCE AND TECHNOLOGY

1. Aperture
2. Lens
3. Viewfinder

Illustration Gary Fields

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Aperture

The aperture of a camera works like the pupil of your eye. It opens or closes to regulate the amount of light coming in.

1 The aperture regulates the amount of light entering a camera.

© Laine / Jerrican

For taking photographs in bright sunlight, a photographer closes down the aperture to reduce the amount of light entering the camera.

In a dark room, the pupil in your eye opens wider to let in more light so you can see. Like the pupil in your eye, a camera's aperture is a small, round hole that is always open slightly. When a photographer takes pictures in low light, he opens the aperture further to let more light into the camera. The film inside the camera needs light to capture an image in a photograph.

Exposure

The aperture regulates the amount of light to which the film is exposed. Proper exposure is essential for a photograph to be clear and for color to be true. If too much light hits the film, the photograph will be overexposed. Too little light causes underexposure.

Teamwork

The camera's shutter regulates how long the light is allowed to penetrate the camera. A photographer coordinates the aperture opening with the shutter speed to take properly exposed photos.

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What metal is contained in a thermometer?

SCIENCE AND TECHNOLOGY

1. Lead
2. Mercury
3. Tin

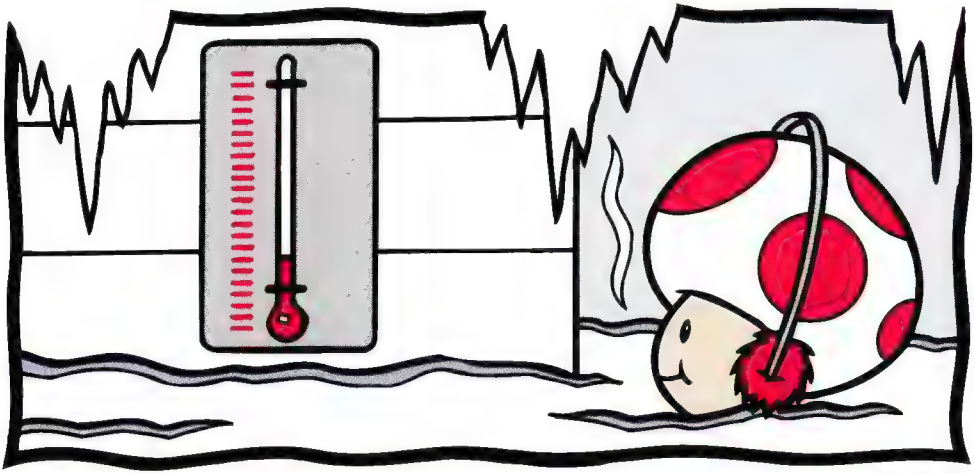

Illustration: Gary Fields

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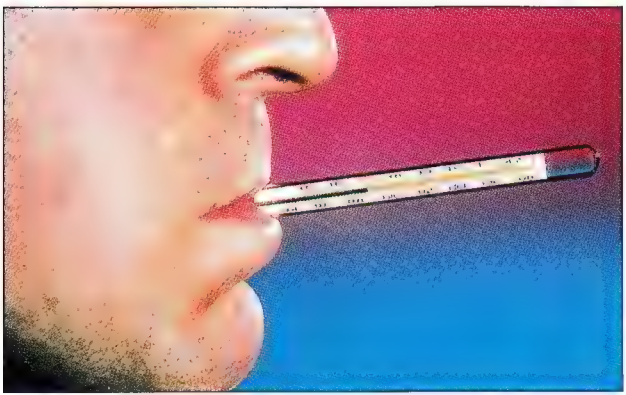
Mercury

The mercury thermometer was invented by German physicist Daniel Fahrenheit in 1714. He also invented the temperature scale we use in the U.S. today.

2 Mercury is contained in a thermometer.



© Len Sirman

As temperature rises, the mercury in a thermometer expands inside the glass tube.

Mercury is the only metal that exists as a liquid at normal temperatures. It's also one of the oldest elements known to man. Ancient Romans called it "living silver."

Moving Metal

Mercury works in a thermometer because heat causes mercury to expand. Since the mercury inside the thermometer is encased in a glass tube, when it expands, the mercury has no place to go but up. This is why, as temperature increases the mercury in a thermometer rises.

Mercury at Work

Mercury has other uses, too. It's used in barometers (the instruments that measure air pressure) and in the thermostats that control home heating systems. It's also used in certain types of batteries and lamps, and in certain paints used by artists. But although it's useful, mercury is dangerous. Swallowing this liquid metal can be lethal.

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Which cleansing process destroys bacteria and microorganisms?

SCIENCE AND TECHNOLOGY

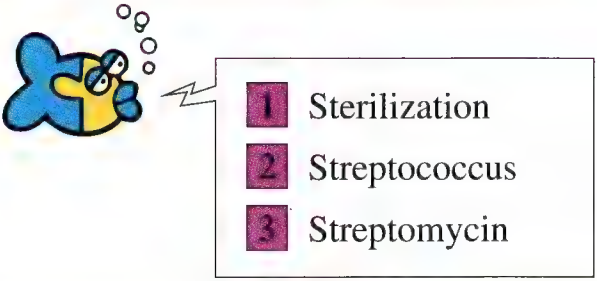

Illustration: Gary Fields

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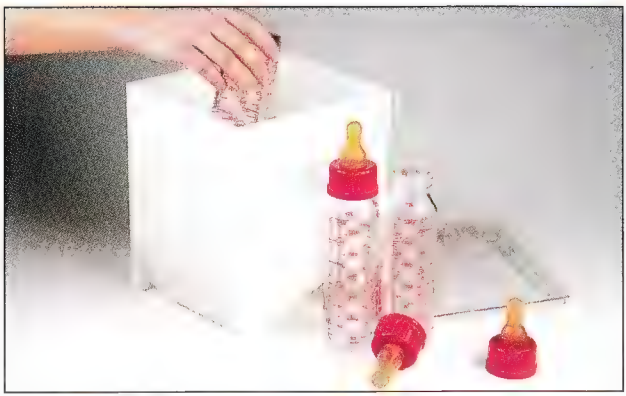
Sterilization

Some bacteria and microorganisms carry disease. This is why sterilization is used to kill bacteria and microorganisms and prevent the spread of disease.

1 Sterilization destroys bacteria and microorganisms.



© J. M. Trois / Explorer

Before they're filled with milk or formula, baby bottles are usually sterilized. Sterilization kills harmful, disease-carrying bacteria and microorganisms.

Sterilization usually kills bacteria and microorganisms by exposing them to extreme heat. Boiling is a common method of sterilization. Mothers sometimes soak baby bottles and nipples in boiling water to sterilize them. Boiling also kills microbes in the water itself. Campers and travelers who might encounter unsafe drinking water generally boil the water to kill harmful bacteria before they drink it.

Medical and dental instruments are also sterilized with heat in special dry or moist heat incubators.

Sterilizing Rays

Radiation, such as ultraviolet rays, also kills microbes. Bacteria, on the other hand, tend to be resistant to radiation sterilization. Unfortunately, radiation is extremely dangerous to humans, so this form of sterilization is not widely used.

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Why was the Thermos bottle invented?

SCIENCE AND TECHNOLOGY

1. To keep coffee hot in the Arctic
2. To store laboratory gases
3. To carry cold drinks in the desert

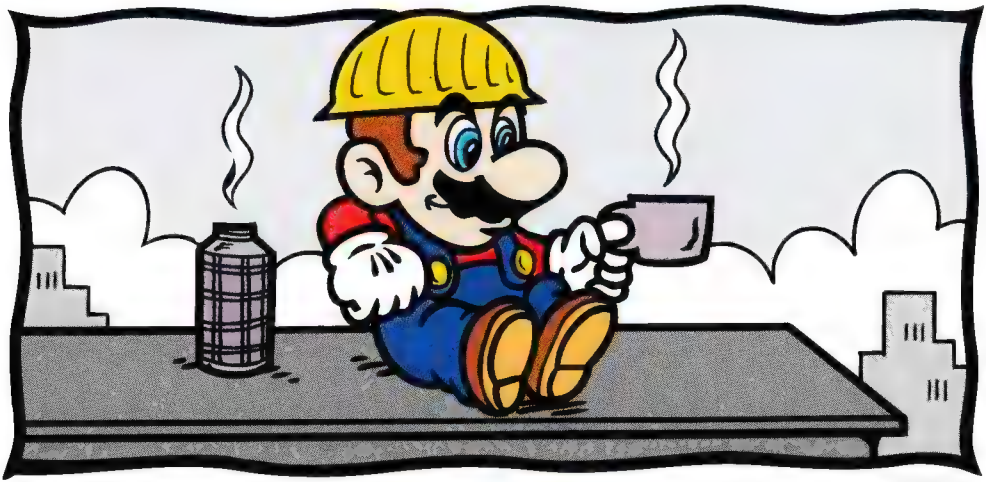

Illustration: Gary Fields

©1996 Nintendo

Thermos

The vacuum flask, which later became known as a Thermos, was invented by James Dewar, a Scottish physicist.

2 The Thermos bottle was invented to store laboratory gases.

© Chamier / Option Photo

James Dewar's laboratory assistant realized the potential of Dewar's invention. He started making vacuum flasks for home use, and he named them Thermos, from the Greek word for "heat." Today, no picnic is complete without a Thermos.

For certain laboratory experiments it was important to be able to store gases or liquids in a sealed space where they would not be affected by temperature changes. Scientists had already discovered the properties of a vacuum—the almost total absence of air. Dewar found a way to store delicate gases and liquids inside a vacuum, where air could not change them.

Dewar's Flask

Dewar constructed a glass flask with a double outer wall, then he pumped out all the air from between the wall's layers to create a vacuum. He applied a silver coating on the inner walls of the glass flask. The silvering reflected heat that might escape from gas or liquid inside the flask and it prevented heat or cold from penetrating the inner chamber of the flask. He sealed the flask with a rubber cap. Safe inside Dewar's flask, lab gases and liquids remained stable and protected.

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What is a phonograph needle made of?

SCIENCE AND TECHNOLOGY

1. Aluminum
2. Diamond or Sapphire
3. Titanium

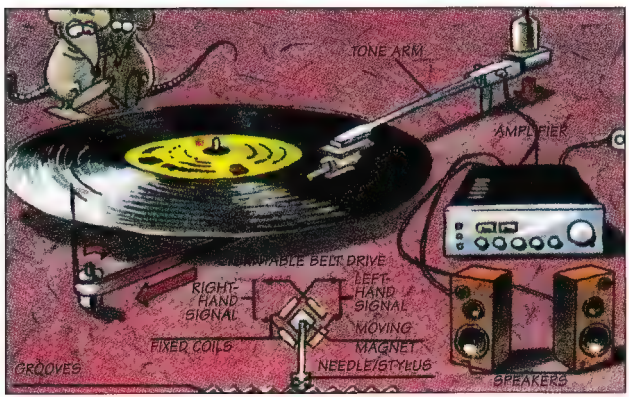
Illustration Gary Fields

©1996 Nintendo

Phonograph

Record players, or phonographs, play sounds recorded on vinyl disks. The record player is the predecessor of the CD player.

2 **Phonograph needles are made of hard minerals like diamond or sapphire.**



© Y. Tabuns.

A record on a turntable spins at a steady rate of speed. The needle, or stylus, at the end of the tone arm vibrates and sends electrical impulses up the tone arm to the amplifier and the speakers.

Thomas Edison invented the phonograph in 1877. It played sounds recorded on a tin foil cylinder. (The first record was Edison himself reading *Mary Had a Little Lamb.*) Later the phonograph was modified to play flat vinyl disks.

How It Works

A flat vinyl disk, or record, contains one continuous notched, spiral groove on each of its two surfaces. Placed on the phonograph turntable, the record spins at a steady rate—usually 33 1/3 or 45 revolutions per minute (rpm).

The needle, or stylus, is surrounded by a magnetic cartridge at the end of the phonograph tone arm. When the arm is lowered, the needle rests in the groove. As the record spins, the groove makes the stylus and cartridge vibrate. The vibrations send an electrical signal through the tone arm to an amplifier and speakers that broadcast the recorded sound.

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When was the concept of the atom first stated?

SCIENCE AND TECHNOLOGY

1. 5th century BC
2. 7th century AD
3. 20th century AD

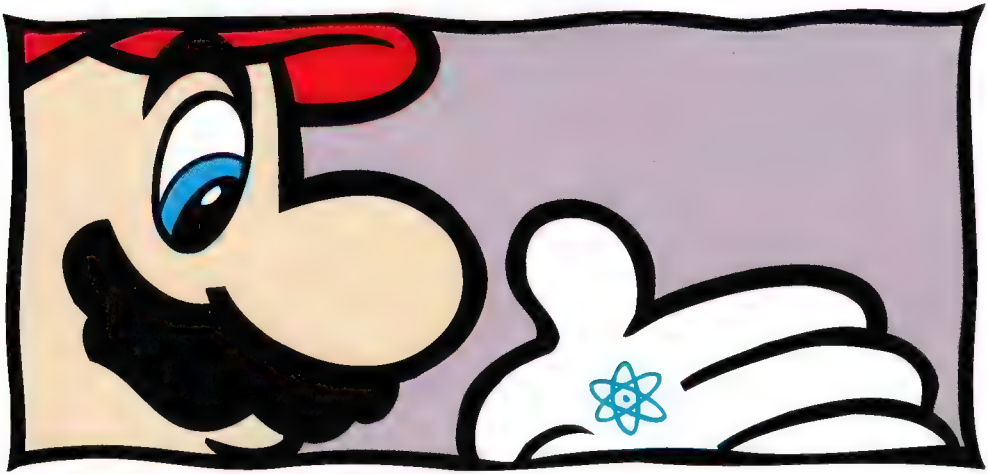

Illustration Gary Fields

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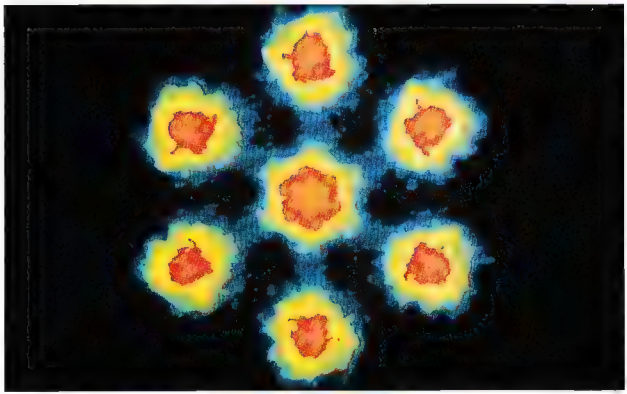
Atoms

The concept of the atom was first stated by the Greek physicist Democritus about 450 BC. It took hundreds of years for other physicists to prove him right.

1 The concept of the atom was first stated in the 5th century BC.



© Ohtsuki / Science Photo Library / Cosmos Imprime en CEE

These atoms were photographed by a special type of high-powered microscope. You'd never be able to see them with your naked eye. They measure about one *fifty-millionth* of an inch long!

How small is an atom? You'll need to use your imagination to picture it.

Itsy Bitsy

Matter is anything that takes up space. This card is matter. Now, think about all the things that form matter. This card is made of paper. Paper is made of wood pulp. Wood pulp contains cellulose, a type of plant fiber. Cellulose is made up of molecules of carbon, hydrogen, and oxygen. Molecules of carbon, hydrogen, and oxygen are made up of atoms, which are so small you need a special high-powered microscope to see them.

Teeny Weeny

Particles that make up atoms are even tinier than atoms themselves. The center of the atom, called the nucleus, contains particles called protons and neutrons. Orbiting around the nucleus at an extremely fast speed are the tiniest subatomic particles of all—the electrons.

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Which is a branch of mathematics?

SCIENCE AND TECHNOLOGY

1. Algebra
2. Architecture
3. Audiology

Illustration: Gary Fields

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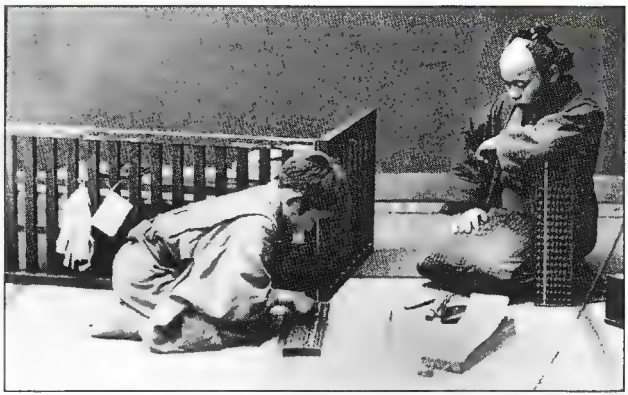
Mathematics

Like science, the study of mathematics is divided into different subject areas or disciplines.

Algebra is a branch of mathematics.



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The abacus, developed in ancient China, is a sort of early calculator that is used to do arithmetic: addition, subtraction, multiplication, and division. Rules, or operations, of arithmetic are the basis for all types of mathematics.

Arithmetic is the first branch of mathematics kids learn. It's the branch of math people use most often. It's also the basis for all other branches of math. Arithmetic involves four basic rules, or operations: addition, subtraction, multiplication, and division. Using these rules, you solve a problem to find an answer. Once you've mastered these skills, you can proceed to learn other branches of mathematics.

Branching Out

Algebra teaches you to think logically when solving problems. In a way, algebra is like backwards arithmetic—you have the answer, and you use the operations of arithmetic to fill in blanks in the question. Geometry, another branch of math, teaches you to calculate the sizes of objects. Carpenters and interior decorators use it all the time—to figure out things like the amount of materials needed to build a cabinet or to carpet a room.

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What product is Henry Bessemer associated with?

SCIENCE AND TECHNOLOGY

1. Plastic
2. Steel
3. Tires

Illustration: Gary Fields

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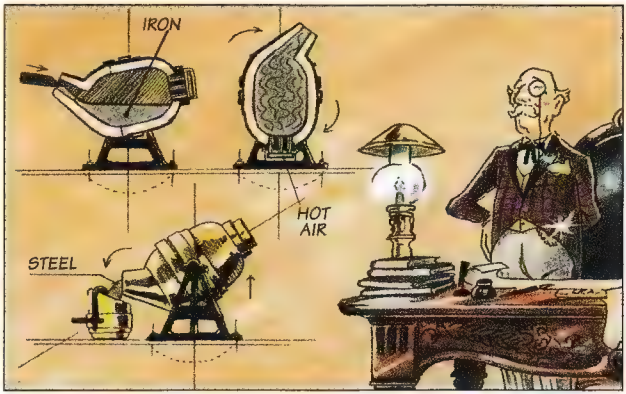
Henry Bessemer

Without English inventor Henry Bessemer, we wouldn't have pencil lead, gold paint, or the steel used to construct buildings.

2 Henry Bessemer is known for his work with steel.



© Y Tabariés

Molten iron is poured into the neck of the Bessemer converter. Then the converter is tilted up and blast of hot air is blown into it through the bottom. Finally, the converter is tilted on its side again and the purified metal is poured out.

From the time he was a boy, Henry Bessemer (1813-1898) had a talent for invention. In his twenties, he patented several inventions, including a method for making pencil lead from graphite.

Striking Gold

Bessemer struck it rich with his method for making inexpensive gold paint from brass. At the time, gold paint was popular for decorating furniture, walls and ceilings. The paint, made from real gold, was expensive. Bessemer's paint did the job as well as gold, but cost far less.

Strong as Steel

He's best known for his unique process of making steel. By blowing a blast of air through molten pig iron, Bessemer removed the iron's impurities and produced steel that was stronger than cast iron. By patenting the process and the design for the converter in which the process is done, Bessemer guaranteed that no one could copy his original ideas and designs.

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Where did glass windows originate?

SCIENCE AND TECHNOLOGY

1. Ancient Rome
2. Ancient China
3. Ancient Polynesia

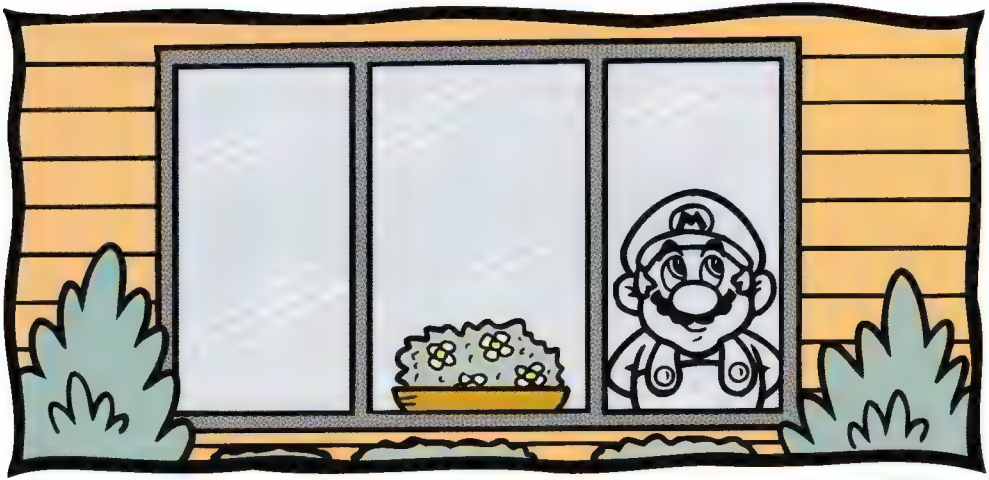

Illustration: Gary Fields

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Windows

Since most of the ancient Roman empire was located in regions with mild weather, glass windows were more of a novelty than a necessity.

1 Glass windows originated in ancient Rome.

© Ph. Roy / Explorer

For architects, the people who design buildings, windows serve both practical and artistic purposes. They let in light and keep out cold, but they also are part of a building's character and beauty.

The people of ancient Germany had more of a need for a way to let light into their homes while still protecting themselves from rain, snow, and cold weather. Around 600 AD, Germany became the world's glass window-making center.

The technology spread north to Scandinavia, from where we get the word "window." It comes from Norse words meaning "wind's eye."

Early windows were usually made from small panes of glass held in place by frames of metal.

Common Touch

When colonists first came to the New World, glass windows were one of the luxuries they left behind in Europe. Some people paid to have windows shipped by boat to America, but most made do by covering their windows with oiled paper that let in light and helped block out foul weather.

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What is alchemy?

SCIENCE AND TECHNOLOGY

1. A science based on turning lead into gold
2. Study of the chemical properties of aluminum
3. The belief that Earth is flat

Illustration: Gary Fields

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Alchemy

Since the earliest civilizations, gold has been the metal most prized by humans. Gold was associated with the sun, and the sun was associated with life.

1 Alchemy is a science based on turning lead into gold.

© Giraudon

The rounded flask in front of the alchemist in this painting was known as a philosopher's egg. It was used by alchemists attempting to produce the philosopher's stone—a magical ingredient that supposedly could turn lead into gold.

The goal of the alchemists was to find a way to manufacture gold. The quest began in ancient Egypt and continued for generations. Some thought blending metals would produce gold. Others believed they had to first discover a "miracle ingredient," known as the philosopher's stone, that could make possible the conversion of ordinary metal, like lead, into gold.

Futile Pursuits

Alchemists were doomed to fail. Gold is an element, which means that it occurs naturally in its pure form and cannot be manufactured. There is no "recipe" for gold. Still, alchemy did have important results for science. In the course of their experiments, alchemists produced a variety of new and useful acids, metallic compounds and other chemical products. They also pioneered techniques, such as distillation, which are used today. The work done by alchemists laid the foundation for modern chemistry.

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What is chalk made from?

SCIENCE AND TECHNOLOGY

1. Limestone
2. Volcanic Rock
3. Iron Ore

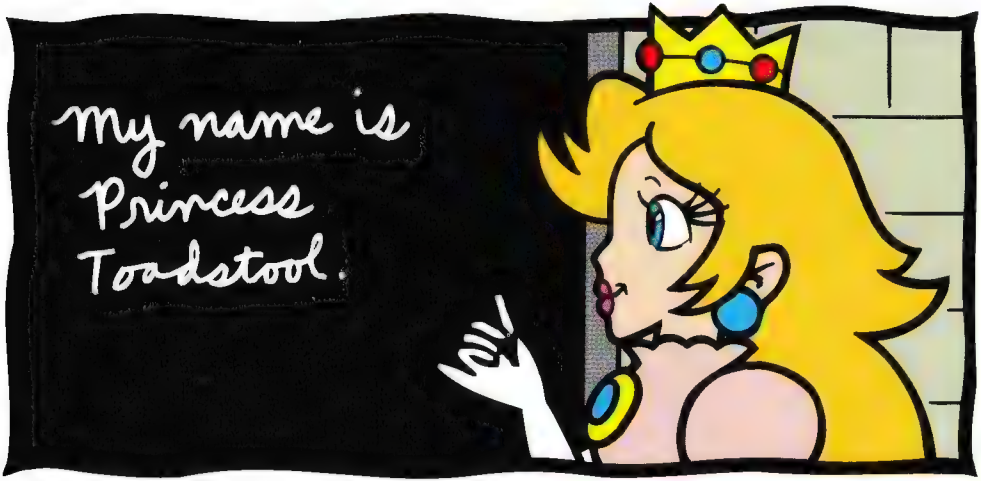

Illustration: Gary Fields

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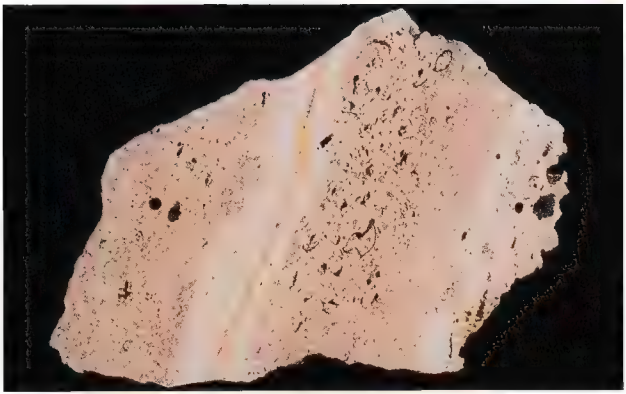
Chalk

The chalk that is used on classroom blackboards in schools contains the fossilized skeletons of tiny sea creatures!

1 Chalk is made from limestone.



© M. Claye / Jacana

In this piece of raw chalk are the skeletons of tiny sea creatures, as small as the head of a pin!

Chalk forms naturally in the mud beneath the sea. It's made of limestone, a soft, sandy form of rock which contains the decomposed skeletons of foraminifera, a tiny sea creature. The skeletons of the foraminifera slowly sink to the bottom of the sea, where they mix with mud and turn to chalk.

While most of the world's chalk deposits exist under the sea, some have risen to land during earthquakes and other geological activity. The most famous chalk deposits on Earth are the "white cliffs" of Dover in England. There also are chalk deposits in Arkansas, Kansas, Louisiana, Texas, and Wyoming.

Make Your Mark

In its natural form, chalk is white. To make the colored chalk you might use on a blackboard or a playground, a colored powder is mixed with powdered raw chalk and then shaped into sticks.

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What provides the energy for hydroelectricity?

SCIENCE AND TECHNOLOGY

1. Water
2. The sun
3. Wind

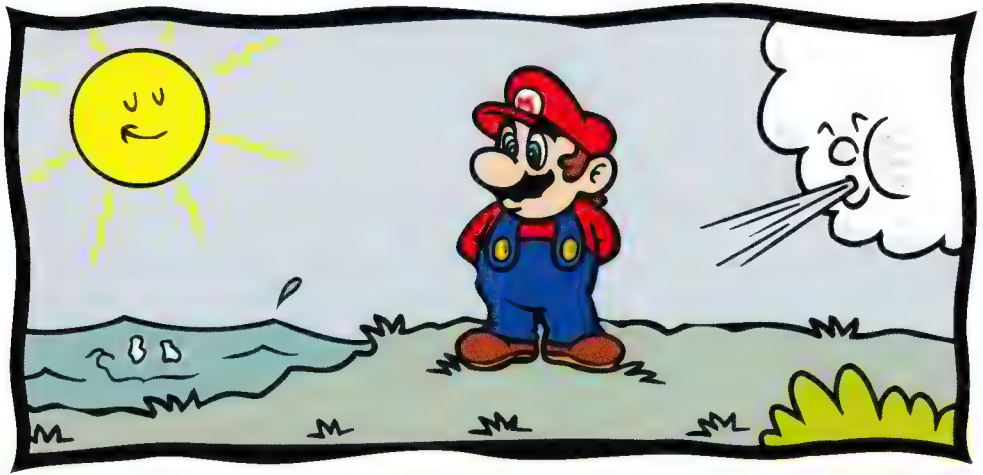

Illustration Gary Fields

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Hydroelectricity

The "hydro" in hydroelectricity comes from the Greek word for water.

1 Water provides the energy for hydroelectricity.

© Timmermann / Sunset

Water from a reservoir flows with tremendous force over a dam and into the power station below.

Hydroelectricity is the transformation of the force or energy of water into electrical energy. As water flows through a hydroelectric dam or power station, it causes turbines to spin. The turbines generate electrical energy. Channels leading into the turbines control the water so that it flows fast but evenly, without waves or turbulence.

Many power stations are attached to or near dams. A dam is a structure that controls the flow of water and forces it to fall from a great height. The falling action gives the water even more force to drive the turbines.

Natural Action

In the same way, a natural waterfall can drive turbines. Ocean waves and tides can also be used to drive generators, however their strength and frequency can be unpredictable which means that the electrical power might not flow at a consistent rate.

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Why are chemical additives added to food?

SCIENCE AND TECHNOLOGY

1. To keep it fresh
2. To make it more attractive
3. Both

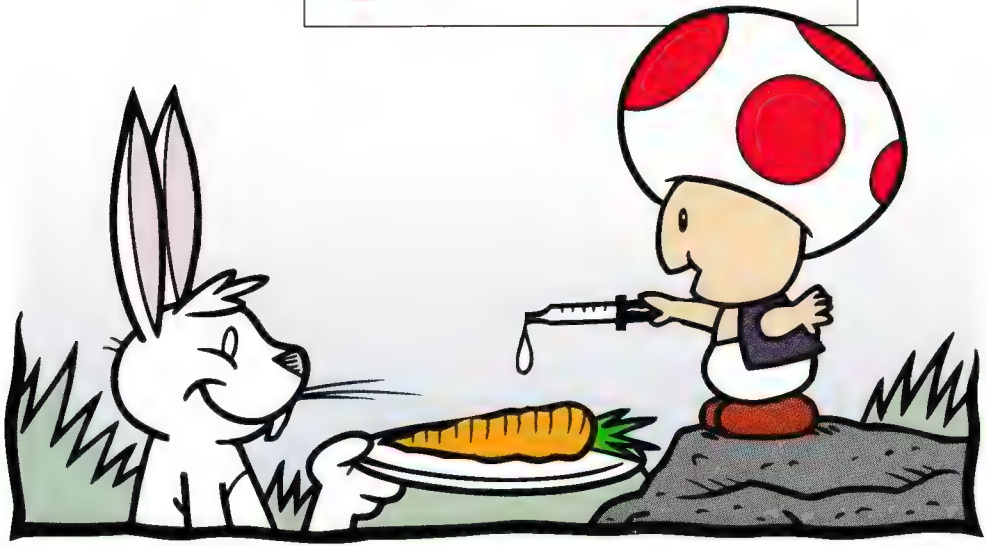

Illustration: Gary Fields

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Food Additives

There are four main categories of food additives: coloring agents, flavoring agents, texturizers, and preservatives.

3 Chemical food additives can keep food fresh and make it more attractive.

© Jerrican

Many candies contain artificial color, flavoring, and preservatives.

Coloring and flavoring agents do just what they say, they change or improve food's color and flavor. Coloring agents are simply dyes that are safe to eat. Some flavoring agents don't have a particular flavor themselves, but the chemicals they contain intensify the flavors of some foods. The best-known flavor enhancer is monosodium glutamate, or MSG, which comes from a natural substance called glutamic acid.

Other additives improve the texture of foods, such as the additives in refrigerated pudding which make it thick and creamy.

Preserve and Protect

Preservatives prevent bacteria and mold from forming on packaged food. They also keep food from spoiling or turning brown or discolored.

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Where do archaeologists find relics?

SCIENCE AND TECHNOLOGY

1. On land
2. Underwater
3. Both

Illustration: Gary Fields

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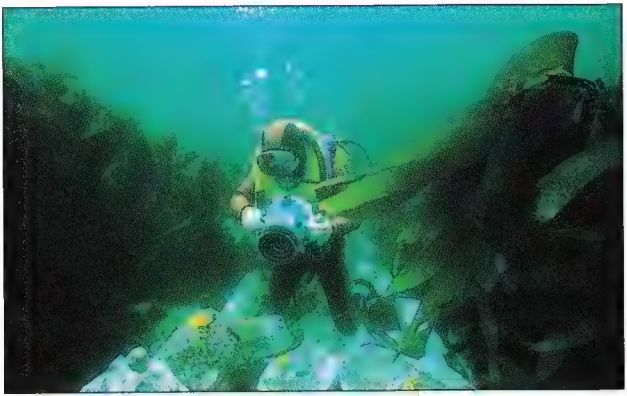
Underwater Archaeology

The sea is a fantastic museum. Besides the fascinating species of plants, fish, and other creatures it holds, the sea also contains historic artifacts and ancient relics.

3 Archaeologists find relics on land and underwater.



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Divers in underwater archaeology expeditions carefully note and photograph the items they recover and where they were found. The location of an artifact can be as important as the artifact itself.

In the same way that archaeologists dig through layers of earth to uncover artifacts from ancient civilizations, underwater archaeologists dive to the bottom of the sea to recover relics and artifacts. Most often, the items recovered are from shipwrecks. Divers have recovered everything from coins and jewels to books and personal items.

Search Missions

One famous expedition was the search for the *Titanic*, a luxury ocean liner which sank in the Atlantic Ocean in 1912. Just finding the wreck took over 70 years!

Once the ship was found, it revealed exciting information to historians. The body of the ship was like an underwater time capsule, filled with hundreds of items that told historians more than they had ever known about the people aboard the *Titanic* during its tragic voyage.

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In which business is irrigation commonly used?

SCIENCE AND TECHNOLOGY

1. Agriculture
2. Auto manufacturing
3. Travel and tourism

Illustration, Gary Fields

©1997 Nintendo

Irrigation

In dry places where there isn't enough rainfall to support crops, farmers use the technique of irrigation to bring water from distant sources to their fields.

1 Irrigation is used in agriculture.

© J-P Porcher, Explorer

In one form of irrigation, sprinklers are used to spray water over crops.

Ancient Egyptians were the first to use irrigation. They dug trenches from the banks of the Nile River to their fields, and diverted water to feed their crops. Using irrigation, the ancient Egyptians turned dry soil into fertile cropland.

Floods and Furrows

The ancient technique is still in use today. There are five main types of irrigation. The method used depends on the amount of water the crops require. Flooding covers a field with water constantly. Furrow irrigation involves cutting ditches, or furrows, between rows of crops and letting water seep into the soil from the furrows. In drip irrigation, water is carried to fields in pipes perforated with tiny holes to control the flow. Subirrigation draws water from underground sources. In sprinkling, water flows through pipes to large sprinklers which spray the water over the crops.

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Which metal is used in the production of nuclear energy?

SCIENCE AND TECHNOLOGY

1. Aluminum
2. Iron
3. Uranium

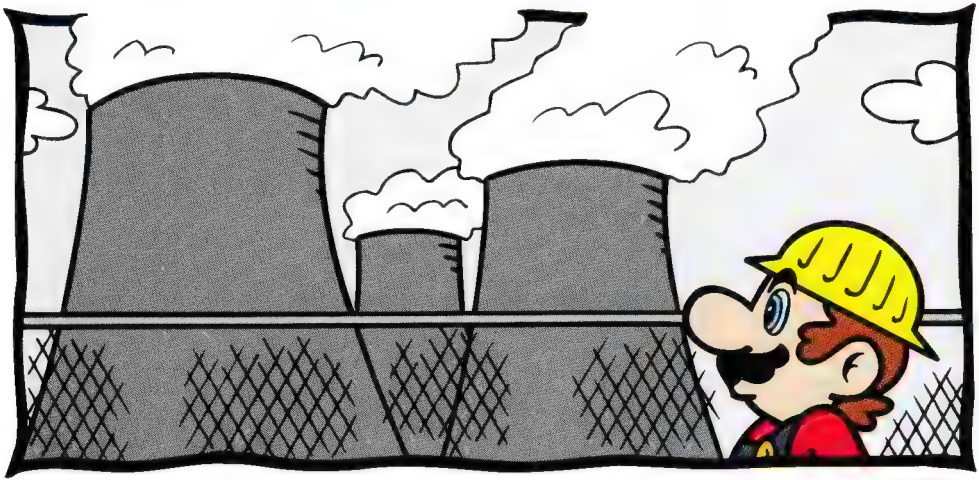

Illustration Gary Fields

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Nuclear Energy

Chain reactions in the nucleus of uranium atoms produce energy in the form of radiation. This chain reaction is called nuclear fission.

3 Uranium is used in the production of nuclear energy.

© Jean Paul / Explorer

Uranium is used in nuclear reactors. The gamma radiation it produces is extremely powerful and toxic. Plutonium, another radioactive element, also is used in nuclear reactors.

At the center of an atom of uranium is an area called the nucleus. It's made up of particles called neutrons and protons. They're constantly moving. When a neutron breaks free from one atom and crashes into the nucleus of another atom it can't be absorbed there. The nucleus only has room for a certain number of neutrons. So, instead, the nucleus breaks apart.

These sections of the nucleus then fly around until they crash into another nucleus and cause it to break apart. This chain reaction keeps going. Each time the particles collide, they produce energy in the form of gamma rays.

Radioactive Pellets

Pellets of uranium are used to power nuclear reactors. The powerful radioactive energy given off by the pellets is collected in the reactor and converted to usable energy.

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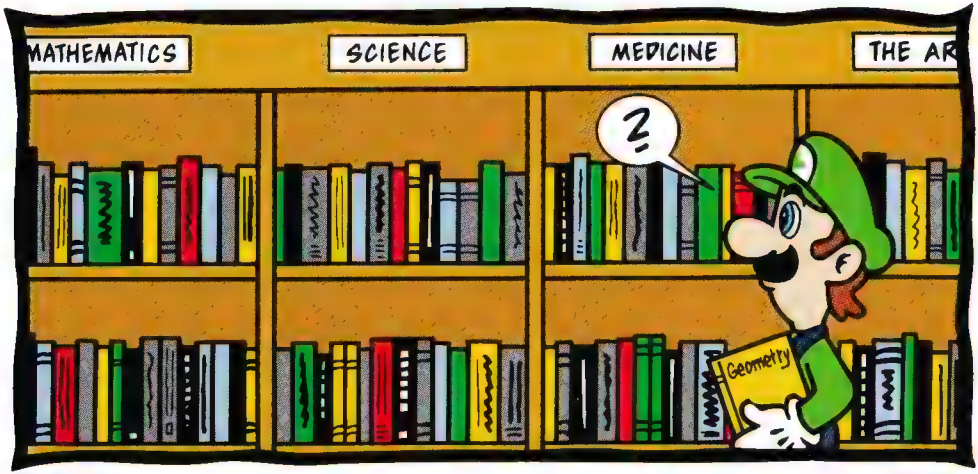
In which field does geometry belong?

SCIENCE AND TECHNOLOGY

1. Mathematics
2. Medicine
3. Science



Illustration, Gary Fields

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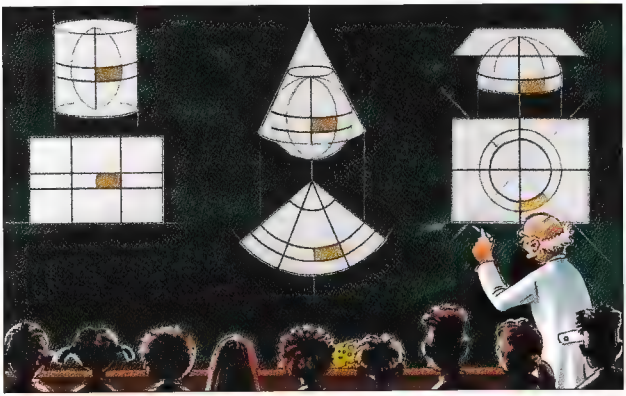
Geometry

The study of lines, angles, and shapes is called geometry. Using geometry, you can calculate the square footage of a room or the angle needed to shoot a billiard ball into a pocket.

1 Geometry is a branch of mathematics.



© Y. Tabanis

Using geometry, mathematicians can calculate precise measurements of any figure, even sections of three-dimensional figures. The drawings on top show the figures in their three-dimensional state. The drawings below show them flattened, or two-dimensional.

The branch of mathematics known as geometry developed as a means to measure things accurately.

Know the Formula

Much of geometry involves the study of figures. Over time, mathematicians have proved that certain figures, like circles, have the same properties no matter how large or small they are. Based on this idea, mathematicians developed equations, or formulas, to measure different aspects of figures.

Circle Game

For example, if you know the distance from one side of a circle to the other, you can plug that number into a formula to find the distance around the perimeter, or circumference of a circle. Since it's easy to measure straight across, but hard to measure around curves, knowing the formula for the circumference of a circle can be handy.

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Where was the first world's fair?

SCIENCE AND TECHNOLOGY

1. London
2. New York
3. Paris

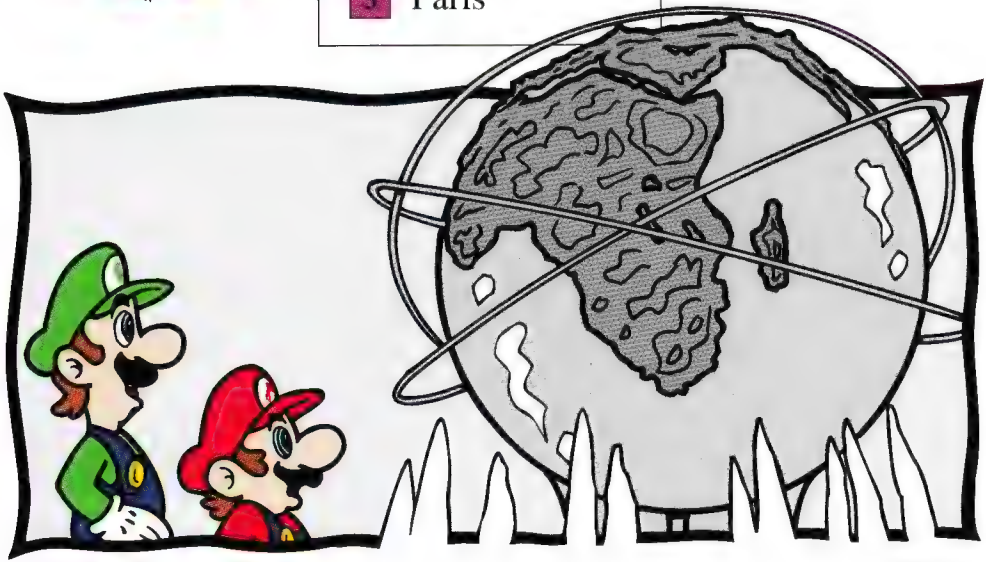

Illustration Gary Fields

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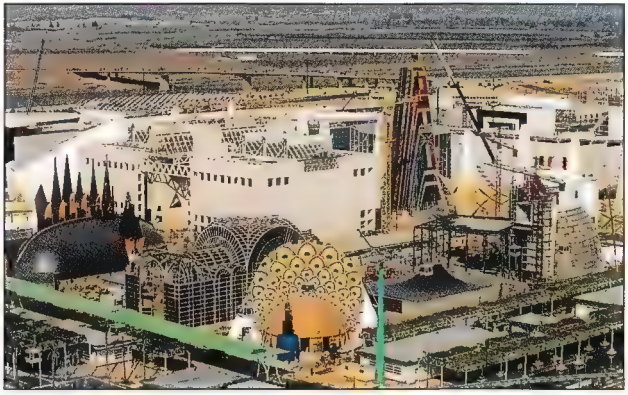
World's Fair

A world's fair is an exhibition that showcases the businesses, industries, and technologies of nations around the world.

The first world's fair was in London in 1851.



© T. Borredon / Explorer

This photo shows construction of pavilions for the 1992 world's fair in Spain.

The first world's fair was held in a building called the Crystal Palace, built in London especially for the event. Other world's fairs followed: Paris (1855), London (1862), Paris (1867), and Vienna (1873).

The first American world's fair was held in Philadelphia in 1876. It was called the Centennial Exposition in honor of the 100th anniversary of American independence.

The host country goes to great lengths to impress its guests with exciting buildings. The Eiffel Tower, for example, was built for the Paris Exposition of 1889.

Governing Body

In 1928, the International Bureau of Expositions was founded to oversee world's fairs. Since its formation there have been world's fairs around the globe, such as: Montreal (1967), San Antonio, Texas (1968), Osaka, Japan (1970), and Brisbane, Australia (1988).

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When was the flashlight invented?

SCIENCE AND TECHNOLOGY

1. 18th century
2. 19th century
3. 20th century

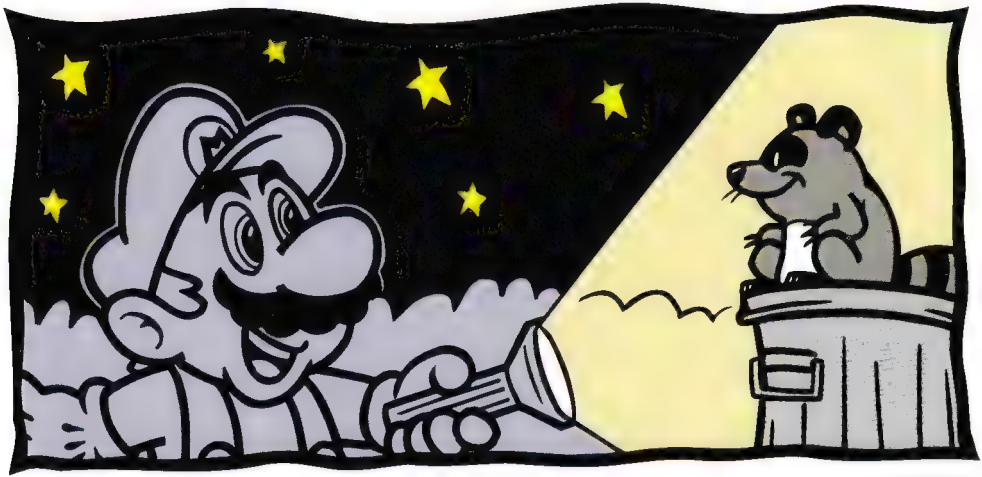

Illustration Gary Fields

©1997 Nintendo

Flashlight

A flashlight is an important part of a household emergency kit. Most drivers keep a flashlight in the glove compartment or trunk of their cars in case of emergency.

3 The flashlight was invented in the 20th century.

© Gamma

Most flashlights are battery-powered, making them efficient and portable.

The flashlight originated in the United States in the early 1900s. It was invented as a novelty item known as an electric flowerpot.

The original flashlight was a metal cylinder with a light bulb at one end. A battery was placed inside the cylinder and the cylinder was inserted in a flowerpot to illuminate a potted plant. It was an interesting idea, but not very practical or necessary. People didn't buy it, and the invention failed.

Starting Over

So, the inventor rethought the idea, took the light cylinder out of the flowerpot, and applied for a new patent for a hand held pocket light. This time, he found success.

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Which device is used to put out fires?

SCIENCE AND TECHNOLOGY

1. Extender
2. Extinguisher
3. Extractor

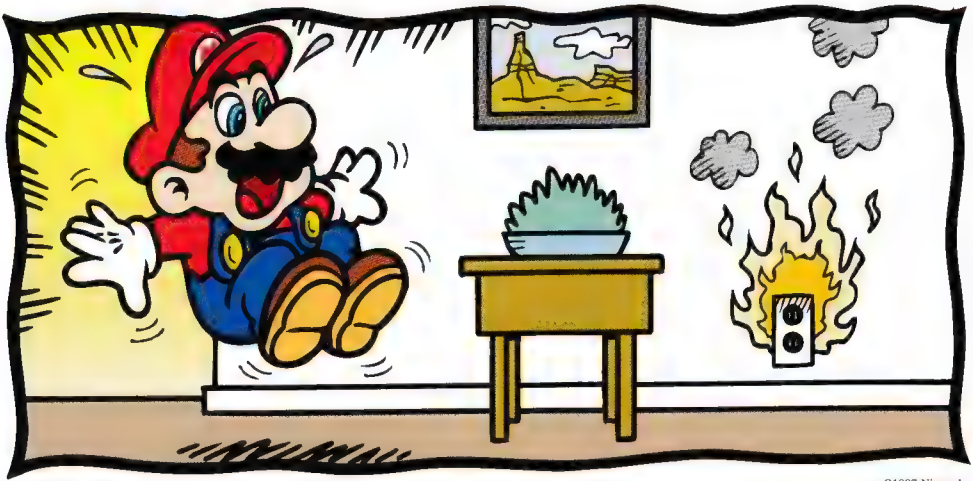

Illustration: Gary Fields

©1997 Nintendo

Fire Extinguisher

One early fire extinguisher was known as a "fire annihilator." It was introduced in London, England, in 1846. It worked by spraying a gas that covered the fire and prevented it from drawing oxygen.

2 An extinguisher is used to put out fires.

© Mutoʻ / Jerrycan

Forest fires can be sprayed with water. They also can be sprayed with dry chemicals or foam.

Different types of fires require different types of fire extinguishers. The National Fire Protection Association classifies fires according to the type of material that is burning.

Class by Class

Class A fires involve wood, paper, or cloth. They may be put out with water, which absorbs the heat and contains the fire. They may also be smothered.

Class B fires involve combustible liquids such as grease and gasoline. These fires must be extinguished by smothering them to stop the flow of air. Extinguishers for Class B fires use dry chemical vapors or foams to smother the fire. Class C fires are electrical fires. Using water on these fires can be dangerous because it causes sparks which can spread the fire. Electrical fires also must be put out with dry chemicals.

Extinguishers that are marked ABC can be used to put out any of these types of fire.

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Why do photographers use electronic flash?

SCIENCE AND TECHNOLOGY

1. To add light when they take a photo
2. To attract the subject's attention
3. To indicate that the shutter has been activated

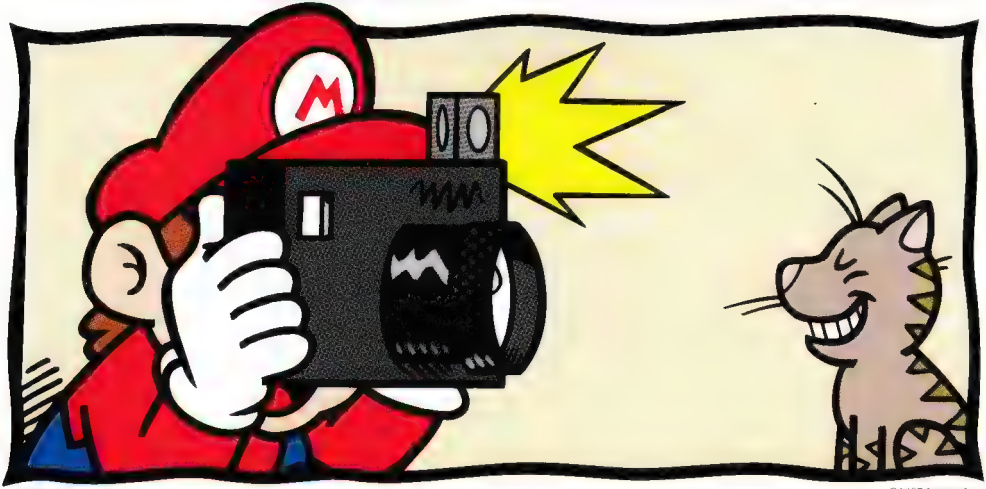

Illustration: Gary Fields

©1997 Nintendo

Flash

Photographers usually use a flash attachment indoors. For outdoor photography, the sun generally provides all the light needed to take a clear picture.

1 A flash adds light for photography.

© Duplan / Diaphor

This photographer has a flash attachment fixed to the top of her camera. She needs the burst of light provided by a flash to capture the action in this dimly lit room. She'd remove the flash attachment for outdoor shots.

There are three types of electronic flash devices. In a studio, a photographer generally uses large, remote flash devices which are attached to power sources. They flash when the photographer depresses the shutter on the camera.

Portable Flashes

When a professional photographer takes pictures at events such as press conferences, fashion shows, or movie premieres, he or she usually uses a flash attachment which is fixed to the top of the camera. These attachments can be heavy and can make the camera unbalanced, but they project a good amount of light. When they're not needed, flash attachments can be removed.

Amateur photographers often have cameras with built-in flash. These flash devices don't throw as much light as the first two types, but they are small and convenient to use.

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What is cryogenics?

SCIENCE AND TECHNOLOGY

1. Medicine studying tears and tear ducts
2. Study of artificial intelligence
3. Study of matter at low temperatures

Illustration: Gary Fields

©1997 Nintendo

Cryogenics

The word cryogenics comes from the Greek word *kryos,* meaning "icy."

Cryogenics is the study of matter at low temperatures.

© Tron / BSIP

In cryogenics labs, cooling chambers are used to produce super-cold temperatures.

In cryogenics, scientists study how matter—solid, liquid, and gas—behaves at extremely low temperatures. Cryogenics is concerned with temperatures below -148°F (-100°C), to as low as "absolute zero" or -459.67°F (-273.15°C). In fact, some scientists work specifically on creating environments in which these super-low temperatures can be duplicated.

Things Change

At very low temperatures strange things happen. Gases, like oxygen and hydrogen turn to liquid. Liquid oxygen is used as rocket fuel. Natural gas, which is used as fuel, is cooled and liquefied to make it easier to transport.

You know freezing preserves food by preventing bacteria or mold from forming. The science of cryogenics is now studying how human organs can be frozen and preserved to be used for future research or in transplants.

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Which device converts sound into electrical current?

SCIENCE AND TECHNOLOGY

1. Microfiche
2. Microphone
3. Microphyte

Illustration Gary Fields

©1997 Nintendo

Microphone

A microphone is one component in a sound system. It can be part of a system that records sound, amplifies sound, or broadcasts sound.

2 A microphone converts sound into electrical current.

The singer sings into a microphone. Her voice is converted into an electrical impulse which is recorded onto a tape.

© J Dang

A microphone is a sound receiver. In a way, it serves the same function as your ears. It detects sound, converts it to electrical impulses, and channels it to other devices that do something with the sound.

Your ears detect sound and send the electrical impulses to your brain. The microphone sends the impulses to an electronic amplifier, which strengthens the signal and makes the sound easier to hear.

Good Vibrations

Inside a microphone is a thin sheet of metal called a diaphragm. Sound waves make the diaphragm vibrate. This motion creates an electrical impulse.

The impulse travels to an amplifier, which may then be connected to a loudspeaker. Or the amplifier may be a component inside a recording device. It may also be part of a system that sends impulses to a transmitter, where they're broadcast through the air as radio signals.

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Which is a means of transmitting television broadcasts?

SCIENCE AND TECHNOLOGY

1. Satellite
2. Semaphore
3. Telegraph

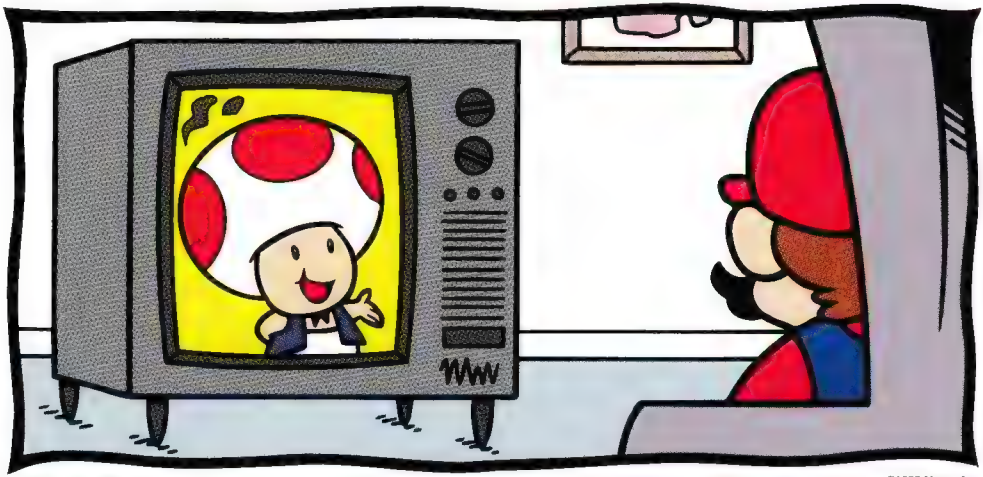

Illustration: Gary Fields

©1997 Nintendo

TV Satellite

Television networks have networks of satellites that are used to beam a broadcast from one place to another.

1 Television broadcasts may be transmitted by satellite.

© Giboux / Gamma / Liaison

When satellite dishes at an Earth station transmit a broadcast to a satellite, it's called an "uplink." When the Earth station receives the broadcast, it's called "downlink."

When you turn on the television to watch a live broadcast of an event, did you ever stop to think that the picture on your TV screen is coming to you from space? Believe it or not, it takes just a few seconds for a broadcast signal to travel from Earth to a satellite in space and back again. This is how many television broadcasts are made.

Earth Link

Cameras that record the event, send their pictures and sound electronically to a large satellite dish, called an Earth station. The Earth station sends the signal up to a satellite that's in a fixed orbit over Earth. Then the satellite amplifies, or strengthens, the signal and beams it back to other Earth stations. From there it's transmitted to your television. This is how you can live in Orlando, Florida, and watch a basketball game that's being played in Portland, Oregon, as it happens.

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What is the boiling point of water?

SCIENCE AND TECHNOLOGY

1. 32°F (0°C)
2. 98.6°F (37°C)
3. 212°F (100°C)

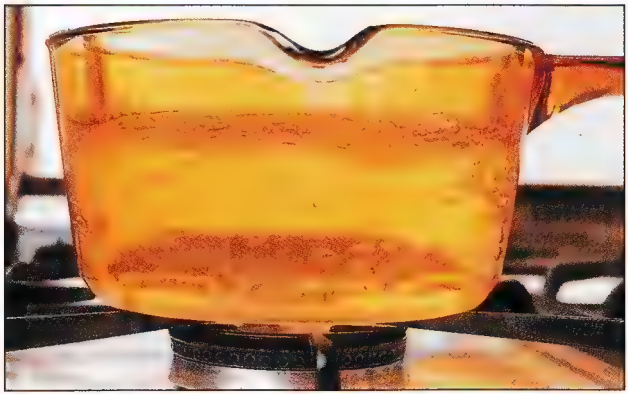
Illustration, Gary Fields

©1997 Nintendo

Boiling Point

A boiling point is the temperature at which liquid evaporates into gas. Boiling point varies for different elements and liquids.

3 The boiling point of water is 212°F (100°C).



© J. Thomas / Jerrican

When water boils it changed form from liquid to gas or vapor.

When a liquid boils, bubbles form on its surface. As the bubbles burst, they release gas or vapor. The gas has the same chemical composition as the liquid, it's just in another form.

A Watched Pot

If you boil a pot full of water, the bubbles burst and release steam, which is water vapor. After a few minutes, you'll see that the water level in the pot has gone down. This is because the water is changing into vapor. Eventually, all the water will turn to vapor.

Bubble, Bubble

Elements that exist on Earth as solids, such as iron, have very high boiling points. To make iron boil, you have to heat it until it melts, or liquefies, then keep heating it until it boils. The boiling point of iron is over 2000°C. Elements that exist on Earth as gases, such as hydrogen, also have boiling points, but they're very low. Hydrogen boils at -252.87°C.

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What is electronics?

SCIENCE AND TECHNOLOGY

1. Study of magnets
2. Study of properties of electrons
3. Study of radio waves

Illustration. Gary Fields

©1997 Nintendo

Electronics

Electrons are electrically charged atomic particles. Electronic devices, such as computers and televisions, work by harnessing the power of electrons.

2 Electronics is the study of properties of electrons.

© Brumaz / Jerrican

As the science of electronics becomes more advanced, components become smaller and more efficient.

When electrical current flows along a closed path, or circuit, electrons jump from atom to atom along the way.

Smaller and Smaller

Early radios and TVs were powered by vacuum-sealed tubes called diodes. Inside diodes, electrons were carried between two points along a wire filament.

A diode worked only as long as the wire filament was intact. If it broke, the diode had to be replaced.

In 1948, transistors were perfected. They were smaller and longer-lasting than diodes, and they allowed for the development of portable electronics, such as transistor radios.

In 1958, the semiconductor, or integrated circuit, was introduced. This paved the way for microchips, which contain thousands of tiny circuits in one thumbnail-sized chip.

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Staples were first used as fasteners on what?

SCIENCE AND TECHNOLOGY

1. Clothing
2. Paper
3. Shoes

Illustration, Gary Fields

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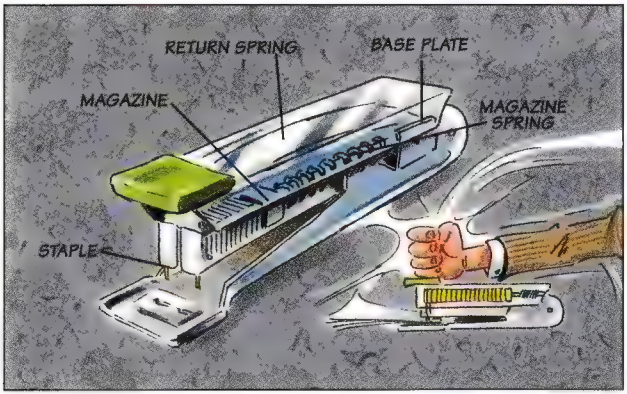
Stapler

The stapler was invented in England in 1868. It was made for shoemakers to join together the soles and uppers of shoes.

Staples were first developed for shoemakers.



© J. Dang

The leaf spring in a stapler is known as the return spring. The coiled spring is called the magazine spring. Magazine is another word for a storage place. A stapler's magazine is where the staples are stored.

About thirty years later, staplers were introduced to the printing industry for fastening together pages of pamphlets. They became standard office equipment by the turn of the century.

Favorite Fastener

Two types of springs are a stapler's primary working parts. In the body of the stapler is a type of spring called a leaf spring. It's made from a strong, flat piece of metal bent into a zigzag. By pushing on the leaf spring you can compress it, but when you release it, the spring returns to its original shape. Pressing on the top of the stapler compresses the leaf spring inside. This forces a staple out of the head of the stapler. On the base of the stapler is a plate, called the anvil, which bends the ends of the staple closed.

A second coiled spring inside the stapler keeps the strip of staples aligned and presses the next one forward into position.

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Why are ball bearings used in some machines?

SCIENCE AND TECHNOLOGY

1. To improve electrical conductivity
2. To make them magnetic
3. To reduce friction

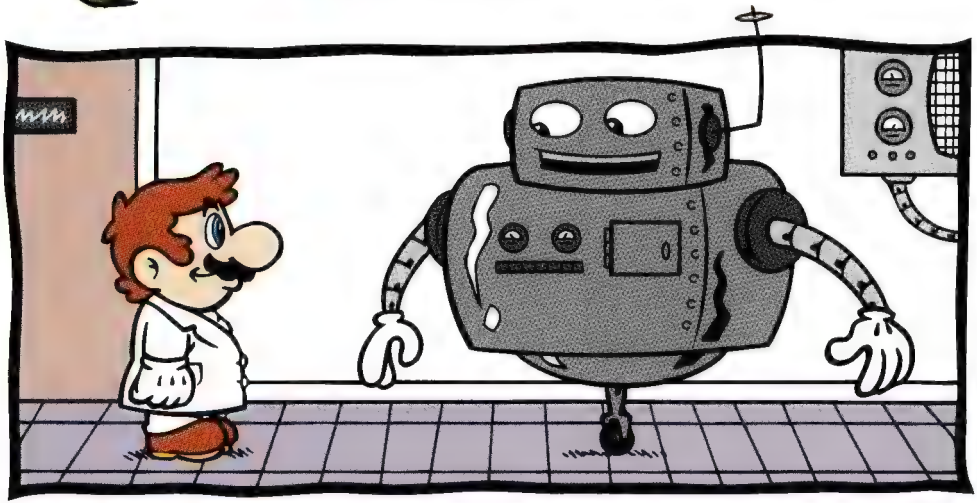

Illustration: Gary Fields

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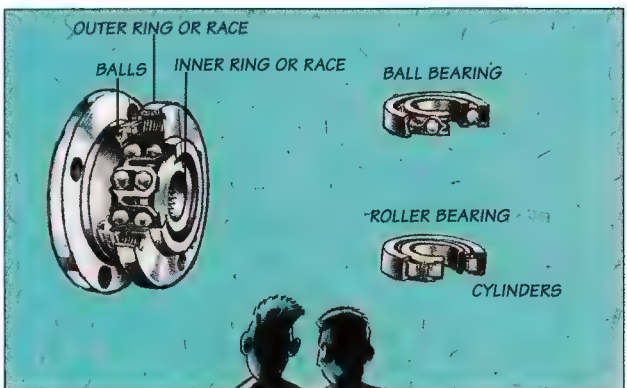
Ball Bearings

If metal machine parts scrape against each other when they move it can cause wear or friction. Ball bearings prevent this from happening.

Ball bearings are used to reduce friction.



© J. Dang

Balls inside a ball bearing are held in position by separators. The balls separate the stationary inner ring of the bearing from the moving outer ring. In a roller bearing, metal cylinders are used instead of the balls.

Friction created when two machine parts rub together generates heat that can damage the machine.

Rolling Along

To prevent friction inside machines, ball bearings are used to separate two moving parts, or one moving part and one stationary part. Inside a ball bearing, a series of small, perfectly round metal balls is positioned between the two parts. The balls let the parts move freely without scraping against each other. Roller bearings work in a similar way, using small metal cylinders instead of balls.

How it Works

Try this experiment: Rub your hands together until you feel them grow warmer. That's friction! Now, place a pencil between your hands and try it again. The round pencil works like balls in a ball bearing. It reduces the friction when you rub your hands together.

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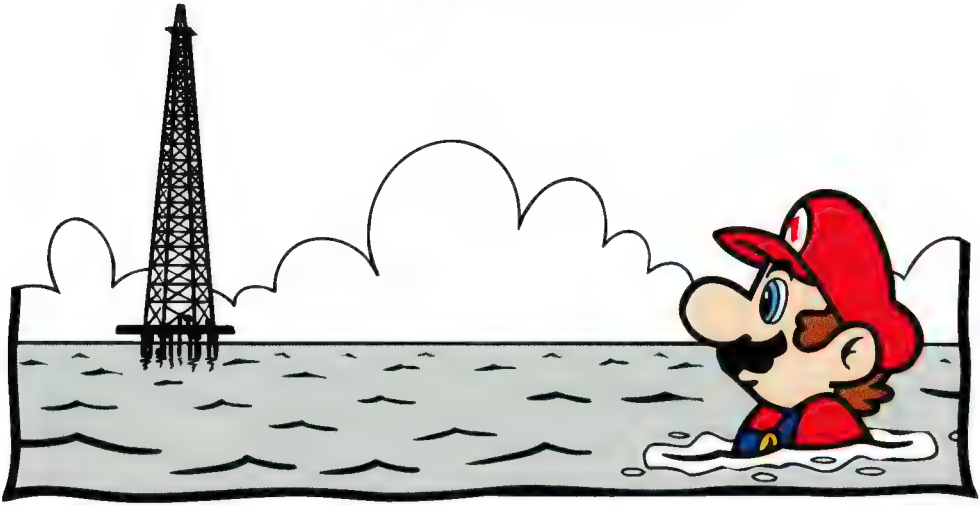
How long do offshore oil rigs last?

SCIENCE AND TECHNOLOGY

1. 1 to 2 years
2. 20 to 25 years
3. 100 years



Illustration, Gary Fields

©1997 Nintendo

Oil Rigs

The average life span of an offshore oil rig is 20 to 25 years. After that, typically, the well runs dry or the rig is so battered by foul weather that it has to be replaced.

2 Offshore oil rigs generally last 20 to 25 years.

© L. Wiame / Sunset

When an offshore oil rig is no longer functional it must be removed. In the United States, this process is overseen by the Minerals Management Service, which also monitors the safety of offshore rigs.

Disposing of an offshore oil rig that has outlived its usefulness is not easy. Sometimes the rigs are deliberately sunk to create artificial reefs for fish and other aquatic plants and animals. In other cases, the rigs are dismantled and dragged back to shore where they are cut up into scrap metal. This takes care of the large structures, but the tricky part is cleaning up smaller pieces of equipment.

Net Gains

Pipes, tools, machinery, and other objects can't be left out at sea where they might threaten the natural environment. Everything has to be collected and accounted for.

In the Gulf of Mexico, certain fishing boats are used for this task. Trawlers are fishing boats that drag huge nets behind them to catch fish. Some trawlers are outfitted with heavy-duty nets, known as "gorilla" nets, which are dragged through the water to collect debris.

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Which colors make up a television signal?

SCIENCE AND TECHNOLOGY

1. Red, Yellow, Blue
2. Red, Blue, Green
3. Red, Black, White

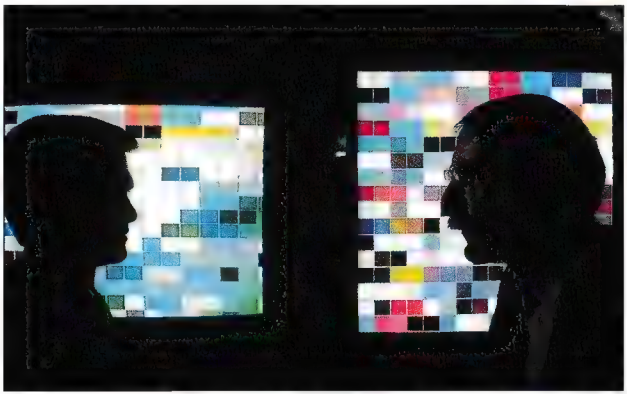
Illustration Gary Fields

©1997 Nintendo

Television

A color television "builds" a picture with stripes of color—red, blue, and green.

2 A television signal is composed of the colors red, blue, and green.



© Len Sirman

Just three electronic beams of color combine to create all the colors on your TV screen.

Every color you see on a TV screen is made up of red. blue, and green. The eye blends them together to make the colors we see. For example, the red and green vertical stripes or dots on the TV screen blend to make the yellow you see.

Inside a television set, the electronic television signal is sorted out and separated into the three colored light signals. Each signal is converted into an electron beam that is directed at the TV screen.

The Line-Up

The picture you see on the screen is constructed from two separate photographic "scans." Imagine slicing a photograph into about 60 horizontal strips of equal width. That's basically what your TV does with its electronic picture. Then it flickers back and forth between showing the odd-numbered strips and the even-numbered strips. The flickering is so fast that your eye can't perceive it. All you see is an image on the screen in living color.

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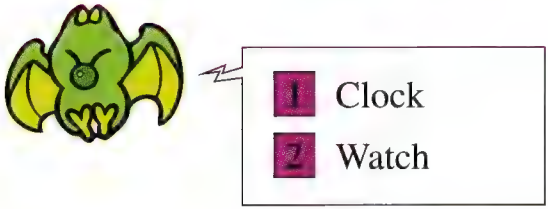
Which was developed first, the clock or the watch?

SCIENCE AND TECHNOLOGY



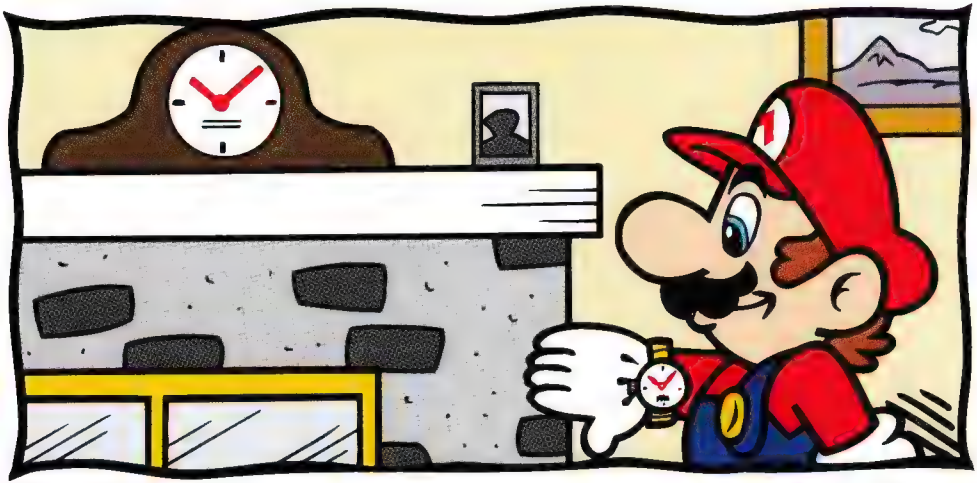


Illustration: Gary Fields

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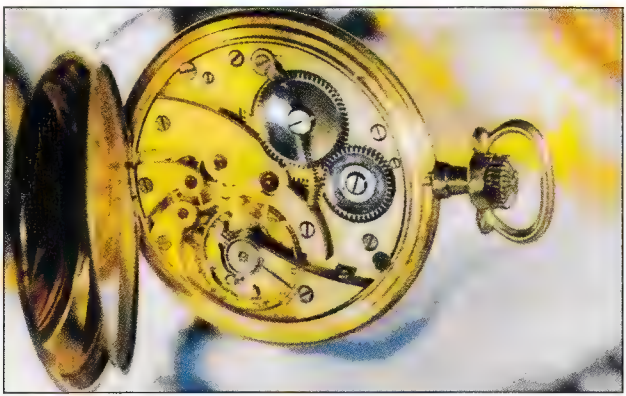
Clocks

Mechanical clocks were developed in the 1300s. They worked by using weights or pendulums for power.

1 The clock was developed before the watch.



© Brossard / Sunset

Old-fashioned pocket watches, like this one, use a mainspring to drive the gears which keep time. In recent years, mainsprings have been replaced with quartz or electronic movements that are powered by batteries.

By the middle of the 1300s mechanical clocks were in use throughout Europe. They were installed in public places, such as town squares, and they chimed every hour.

Gears inside these large clocks controlled the fall of an internal weight. As the gears turned, the weight fell notch by notch. When the weight reached "bottom" it was raised again using a pulley. This mechanism worked for huge clocks, but it wasn't portable.

Time on Your Hands

Watches couldn't be developed until someone devised a smaller, portable mechanism to run a clock. This occurred in the 16th century when the mainspring was developed. A mainspring is a coiled metal spring that can be wound up tightly. As the spring unwinds, it drives the gears that run the clock. Mainsprings could be small and light enough to be fit into portable timepieces. By the mid-1500s, many people carried watches.

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What are ceiling fans used for?

SCIENCE AND TECHNOLOGY

1. Heating
2. Cooling
3. Both

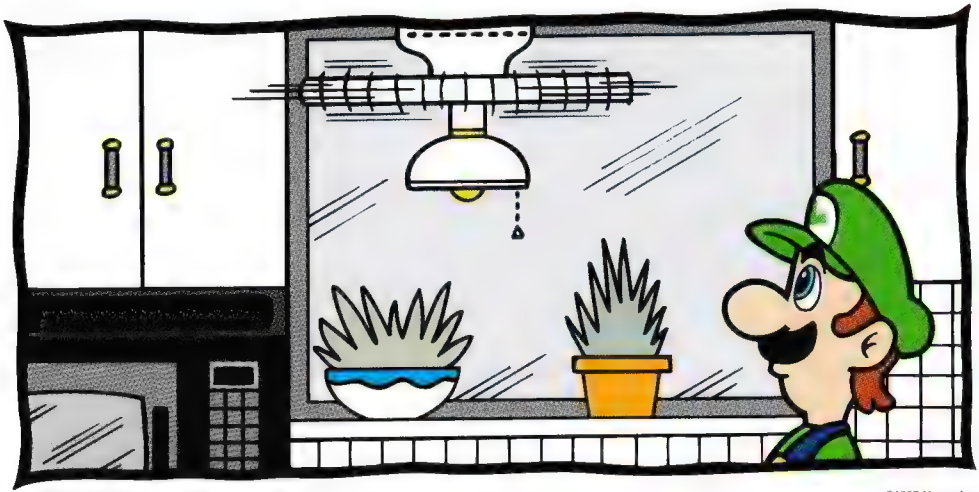

Illustration Gary Fields

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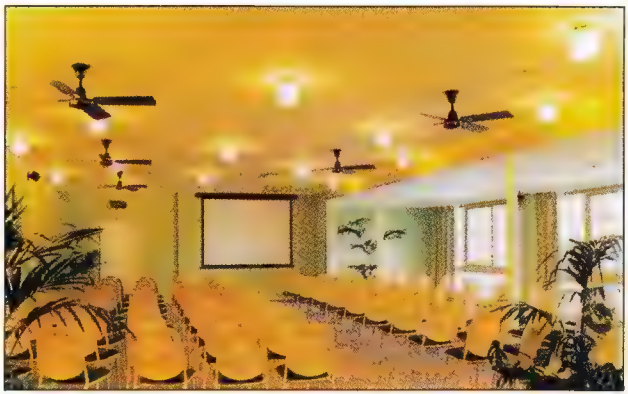
Ceiling Fans

The ceiling fan was introduced in the 1890s. The most common type of ceiling fans are suspended by a rod from the ceiling. Their blades direct air downward.

Ceiling fans can be used for both heating and cooling.



© Index Sr. / Sunset

One ceiling fan is usually enough to keep a room in your home cool in summer. Large rooms, like this one, require more than one fan.

To work efficiently, ceiling fans are generally mounted 8 to 9 feet (2.4-2.7 m) above the floor. The blades of the fan should be at least 8 inches (20 cm) from the ceiling. Any closer than that and the air becomes trapped between the blades and ceiling and doesn't circulate throughout the room. Most ceiling fans have four blades, but some have more or fewer. Fans with fewer blades move the most air. Extra blades put more drag on the fan's motor which means that the blades turn slower.

Cold Weather Warmer

Though it might seem strange to operate a fan during the winter, the fan works to warm the room by circulating the warm air from a room's heating system. Because warm air rises, the fan works to push it down from the ceiling and back into the room.

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What unit of measurement indicates a battery's strength?

SCIENCE AND TECHNOLOGY

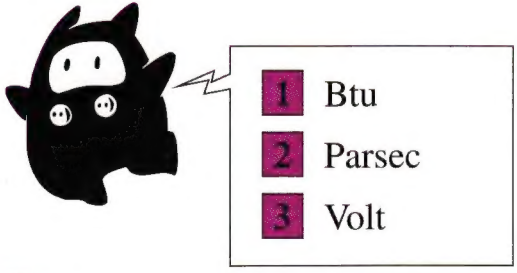

Illustration: Gary Fields

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Volts

The unit of measurement known as the "volt" was named for Alessandro Volta, the physicist who invented the battery.

3 Volts indicate a battery's strength.

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Electric cars, like this one, are powered by a series of heavy-duty batteries which must be recharged periodically. Ordinary gasoline-fueled cars use batteries to power their electrical devices such as headlights and windshield wipers.

Alessandro Volta's battery was the first device that could be used to provide a continuous current of electrical power.

Leading the Charge

In the late 1700s, Volta was a physics professor in Italy. He specialized in the study of electricity. At the same time, Volta's friend Luigi Galvani discovered a phenomenon he called "animal electricity," when he found that a frog's leg hung from a brass hook above an iron railing twitched when it came in contact with the railing.

Volta found that Galvani wasn't entirely correct. The electricity didn't come from the frog leg, it came from an electrical charge that was generated between the two different metals—brass and iron. From this discovery, Volta proved that two different metals placed in close proximity could create an electrical charge.

His first electrical battery, introduced in 1800, contained "cells" of silver and zinc connected in a series.

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How did the word "robot" originate?

SCIENCE AND TECHNOLOGY

1. It's an invented word
2. It's an acronym
3. It came from a science fiction story

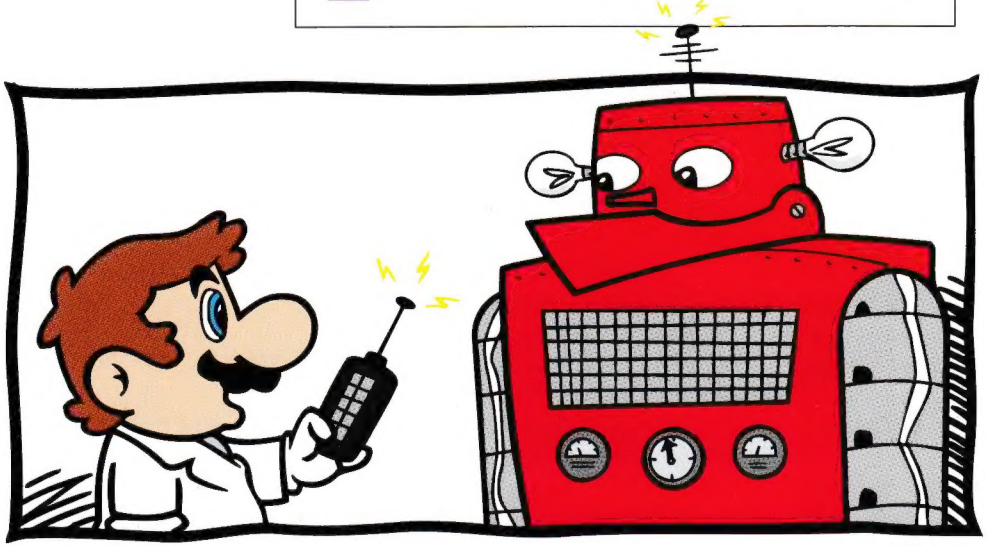

Illustration: Gary Fields

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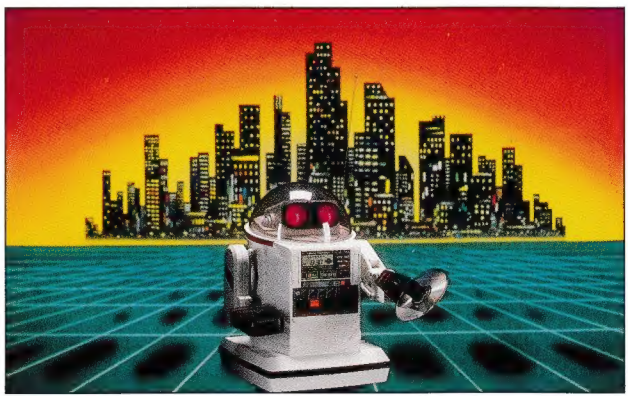
Robots

In 1920, Czech writer Karel Capek wrote a story called *R.U.R.*, which was later made into a play. The story concerned a group of automated workers called "robots."

3 The word "robot" came from a science fiction story.



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Science fiction robots look like humanoids. In real life, robots are more machine-like.

The Czech word *robota* means "work." Capek used this as the basis for the word "robot." When Capek's play was translated into English, the translators kept the original term.

Man or Machine?

In science fiction, robots usually work or behave like humans. Think of the robot housemaid on *The Jetsons* cartoon series for example. In real life, however, robots are machines created to perform specific tasks. So, a robot might consist only of an arm or pair of arms.

Jobs for Robots

Robots perform repetitive tasks, such as those on manufacturing assembly lines. They're also used to for hazardous tasks. Working with radioactive samples could be lethal to humans, but it won't harm a robot. Robotic devices also are used to perform certain surgical procedures. Computerized robots can be programmed to perform with perfect precision.

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